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WATER & AIR QUALITY TRENDS IN REGION 8

UNITED STATES
ENVIRONMENTAL PROTECTION
AGENCY
DENVER, COLORADO 80295

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The air quality report provides information where quality standards are achieved as well as areas which still have significant problems. Indices are used where appropriate.

This report was not intended to be a comprehensive analysis of cause and effect relationships.

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WATER AND AIR QUALITY TRENDS

IN

REGION VIII

U.S. ENVIRONMENTAL PROTECTION AGENCY

Data Analysis Branch
Surveillance and Analysis Division
Denver, Colorado 80295
March 1978

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SECTION I

WATER QUALITY REPORT

INTRODUCTION

The purpose of this report is to present summaries and trends for STORET resident data collected at active data-rich monitoring stations located on the major stream segments of Region VIII.

The trend data for this analysis which represents observations made during subsequent time periods was selected so as to provide for a two-year overlap, to aid in eliminating some of the bias that might arise because of year-to-year flow differentials.

The first period of study was from January 1, 1971 to December 31, 1974. The second period began January 1, 1973 and ended December 31, 1976.

This report does not attempt to classify or precisely determine stream quality or to analyze detailed cause and effect relationships. It attempts, rather, to impart a sense of status and trend (i.e. improvement, degradation, etc.,) by comparing simple mathematical ratios of water quality violations to water quality observations in successive time periods.

Data are summarized and reported in two ways; (1), as a single parameter percentage of standard or criteria violations, and (2), as a single "index" number derived as the product of percentage violations of several parametric groups.

This effort to organize and manipulate water data by completely divorcing it from existing knowledge of geography, hydrology, or land use practices (except where unavoidably obvious) and considering only numerical variations, is the logical first step in the statistical approach towards a total environmental related water quality analysis.

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SUMMARY AND FINDINGS

The discussion in this section reports results for the four pollutant groups analyzed in the study. It includes information about their predominance in the main streams of the region and their combined effect on overall water quality as represented by the Region VIII Water Quality Index.

The groups are:

Oxygen Related
Bacteria
Nutrients (Nitrogen and Phosphorus)
TDS

Oxygen Related Group

Group Effects and Characteristics

The oxygen related group is generally more significant and applicable to streams passing through populous areas where wastes are present in the water. The two interrelated parameters comprising this group are:

Dissolved Oxygen (DO): The availability of high dissolved oxygen concentration in a stream is a measure of good quality and indicates that the water can adequately support aquatic life and rapid bacteria propagation for assimilating wastes quickly.

Biochemical Oxygen Demand (BOD): This measurement indicates the amount of oxygen that is being used in the stabilization of organic matter by microorganisms. The higher the BOD load the more dissolved oxygen is required and this in turn lowers the dissolved oxygen concentration.

Findings

Problems are apparent at several stream segments in the region (see Figure 1). The analysis indicates that the Jordan River below Salt Lake City, Utah has the highest percentage of oxygen related violations. Although data of the U.S. Geological Survey continuous monitoring station at their Henderson station on the South Platte River is not in STORET, the USGS reported that dissolved oxygen concentration dropped below 5 mg/1 practically every day of the year. These violations are probably caused by the large number of municipal treatment plants found along the two stream segments that are located within large metropolitan areas. Other stream segments in the region (shown in yellow) indicate marginal problems which are probably caused by municipal treatment plants and livestock wastes draining into the stream.

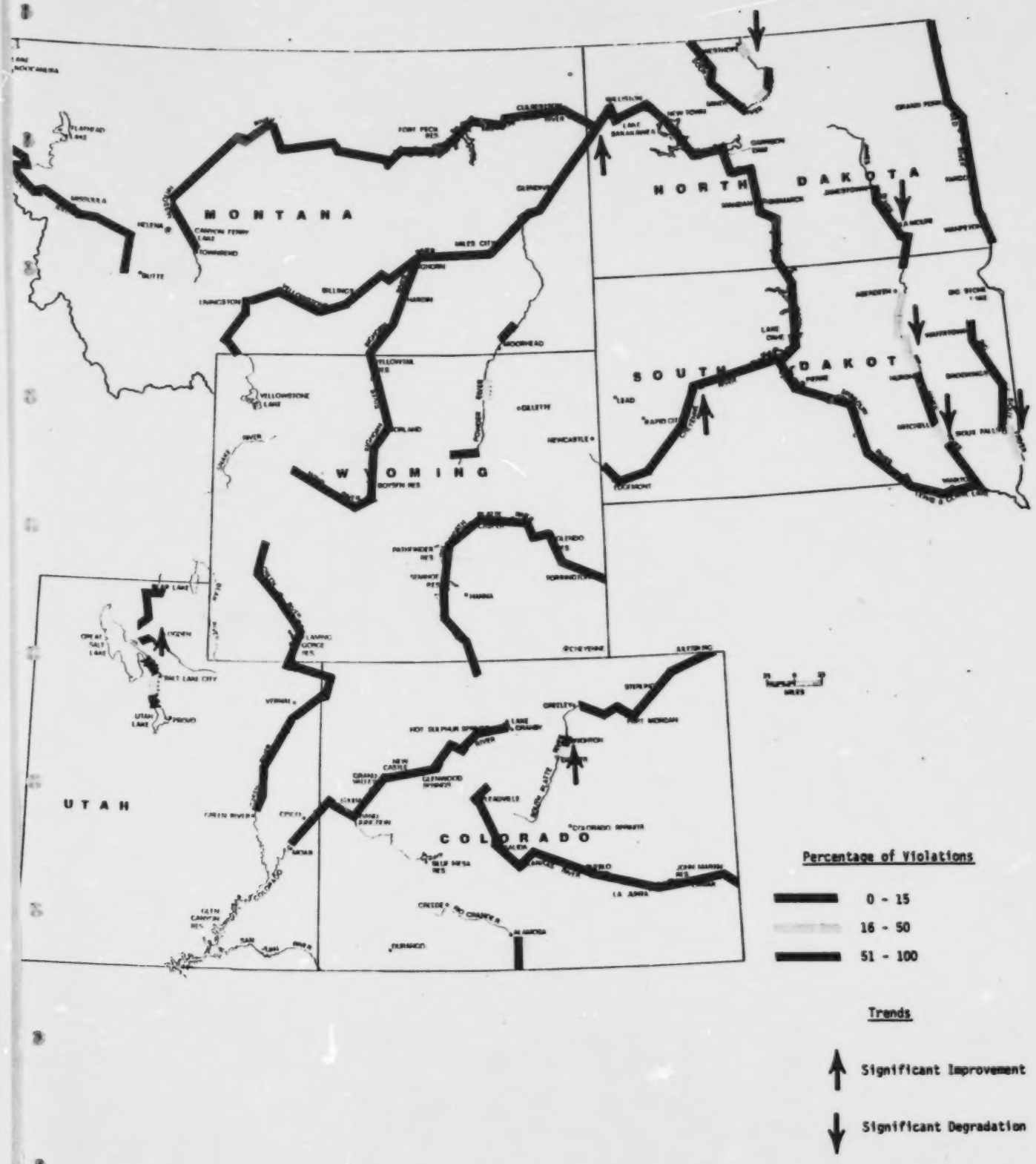

Figure 1. Standards/Criteria Violations -- Oxygen Related Group.

Bacteria

Group Effects and Characteristics

The parameters reviewed for this group are total coliform and fecal coliform. Presence of fecal organisms in the stream is indicative of sewage or pollution from warm-blooded animals, including man.

Findings

Figure 2 illustrates a substantial number of problen segments in the Region. The significant problem areas are located mainly below municipalities. Most of the minor problem segments shown in yellow can be characterized as being impacted from municipal wastewater treatment facilities, drainage from areas containing livestock, and irrigation return flows containing manure fertilizers.

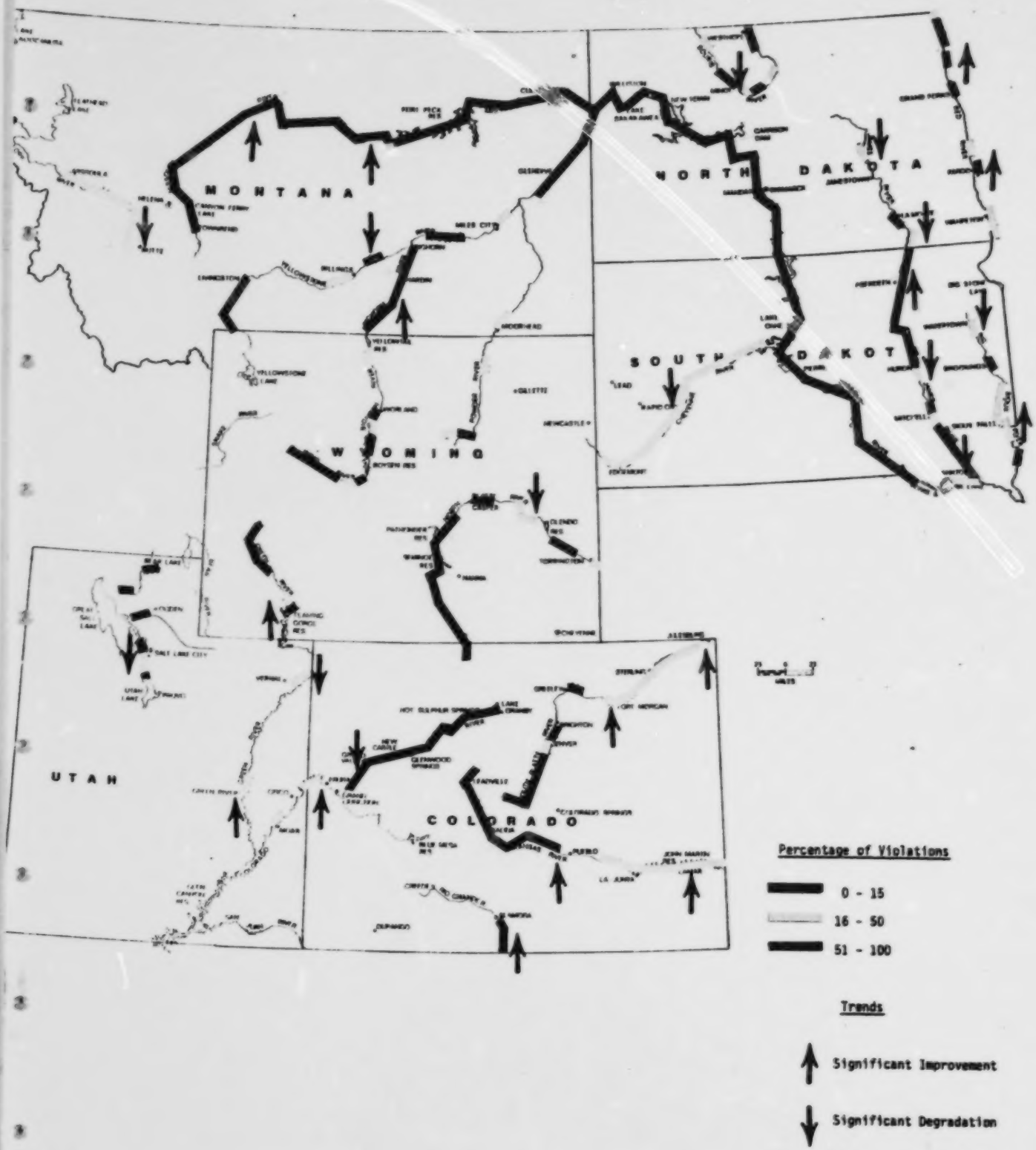

Figure 2. Standards/Criteria Violations -- Bacteria.

Group Effects and Characteristics

Municipal wastewater discharges, livestock wastes and fertilizers that have been applied to irrigated fields are the main contributors of nitrogen concentrations in the stream. Various forms of nitrogen are evaluated in the index calculations. Excessive concentrations of most nitrogen forms have deleterious effects on biotic life yet each stream segment requires independent analysis to determine its limiting characteristics. Nitrogen and phosphorus when in certain combination can pose a eutrophication hazard to relatively slow moving bodies of water along a stream course.

Findings

The map shown in Figure 3 illustrates the relative differences in nitrogen concentrations found in waters in Region VIII. The flow of nutrient rich irrigation return is the primary contributor to poor stream quality for those segments of the South Platte River, Arkansas River, and the Colorado River.

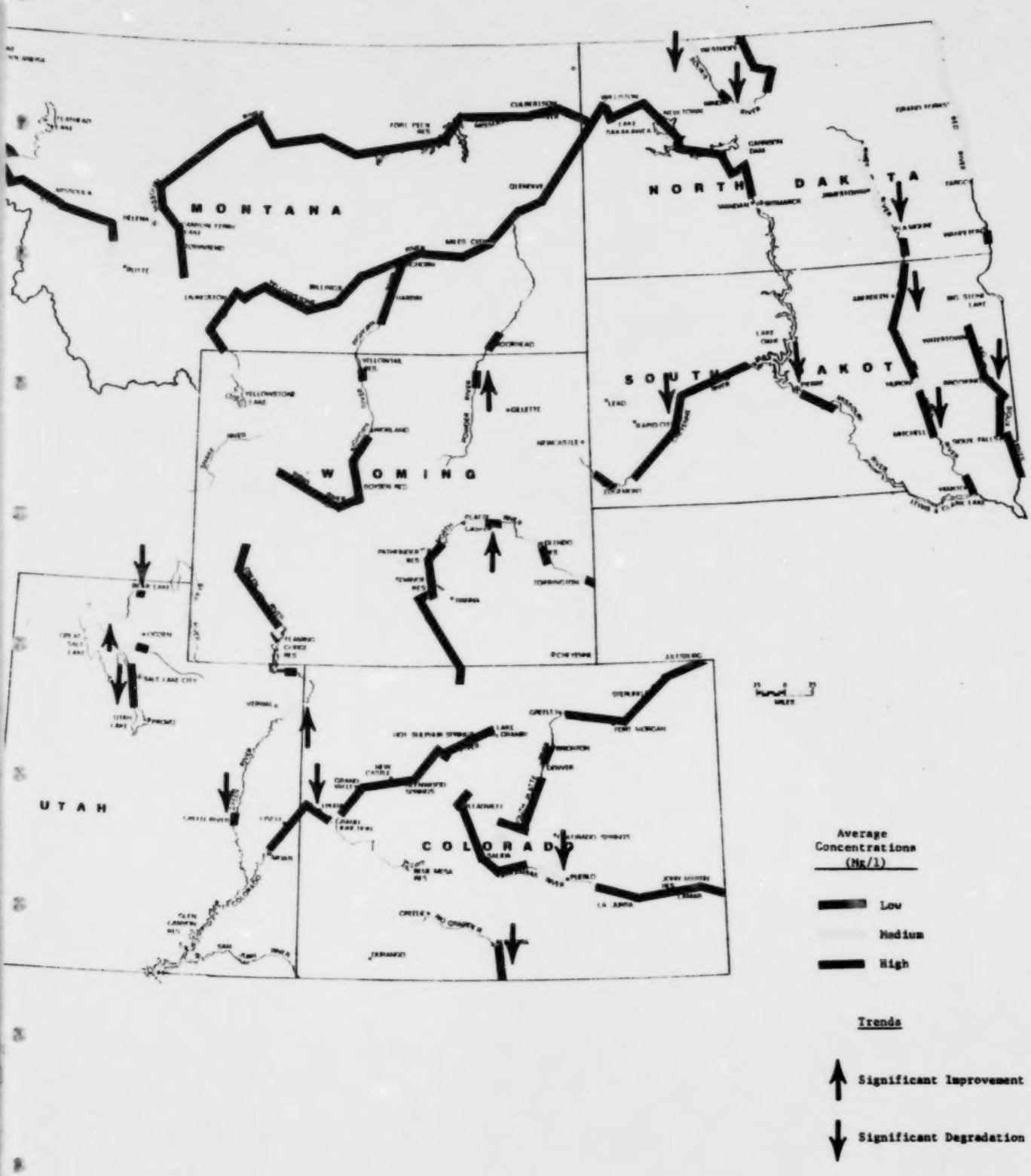

Figure 3. Relative Concentrations of Nitrogen in Major Streams of Region VIII.

Phosphorus

Group Effects and Characteristics

Perhaps the most important characteristic of phosphorus is that it can stimulate algal production in the presence of nitrogen and carbon.

Findings

The map shown in Figure 4 illustrates that the presence of phosphorus is detected in all Regional streams in varying concentrations. The map also suggests that the contribution of phosphorus is principally due to natural sources. A recent publication from our Corvallis laboratory[1/] states that there seems to be little or no relationship between geologic formations and phosphorus derivations. Our findings suggest a definite relationship between phosphorus concentrations and the geology in Region VIII. This does not, however, negate the fact that loadings from irrigation returns are highly significant.

1/ Omernik, J.M., "Nonpoint Source-Stream Nutrient Level Relationships: A Nationwide Study," EPA-600/3-77-105, Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon 97330.

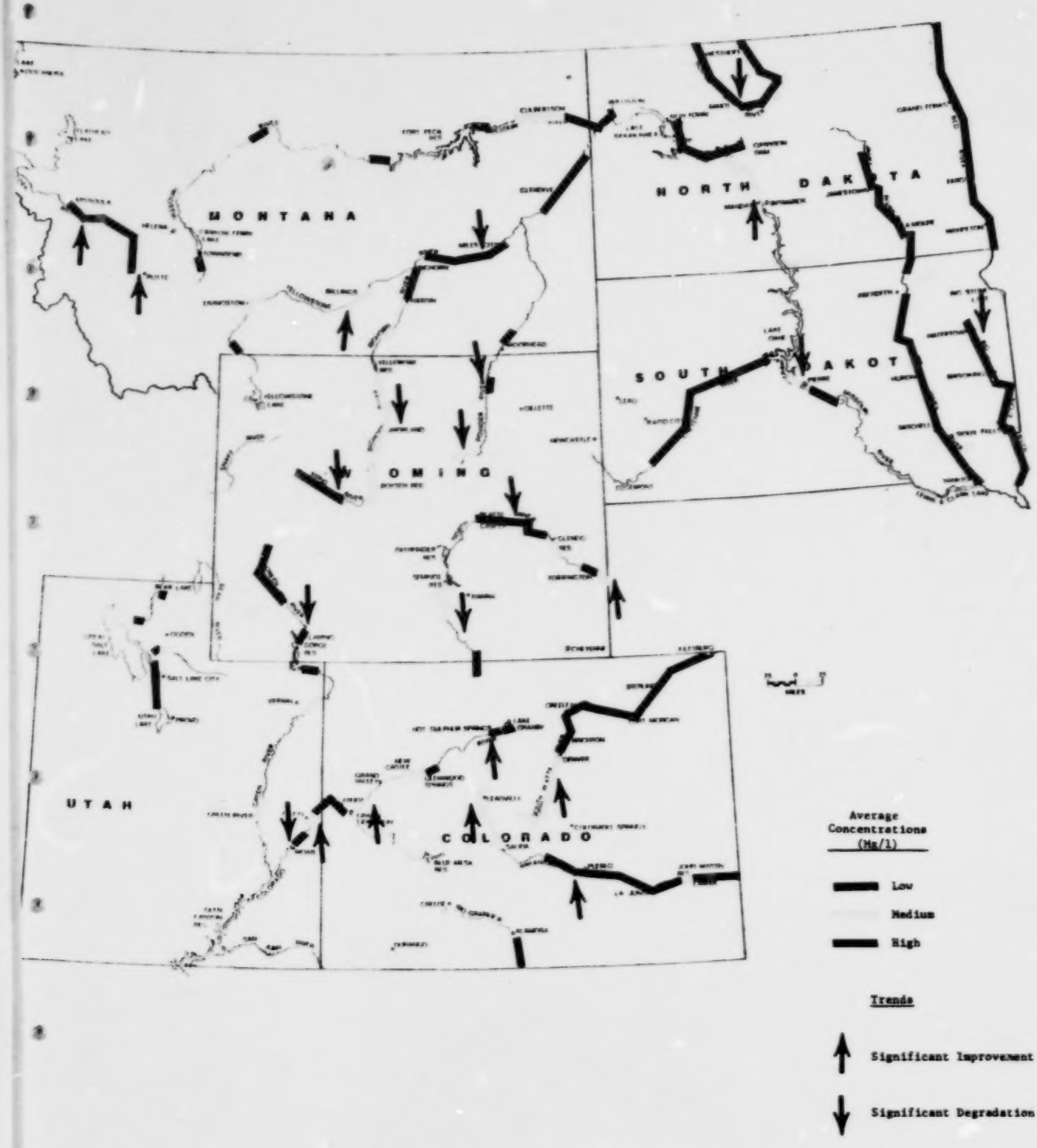

Figure 4. Relative Concentrations of Phosphorus in Major Streams of Region VIII.

Group Effects and Characteristics

Total Dissolved Solids is the measure of nongaseous minerals in solution in water - its relative "saltiness" or "hardness." Hardness effects water taste and causes increased costs for water softening and shortened life expectancies of household plumbing and appliances. High concentrations of TDS in the streams are of utmost concern to agricultural irrigators. These high concentrations also decrease crop yields in addition to taking land out of production where excessive salts have accumulated in the soil.

Findings

The map of TDS Standards/Criteria Violations (Figure 5) shows the predominance of violations determined for the streams of the Region.

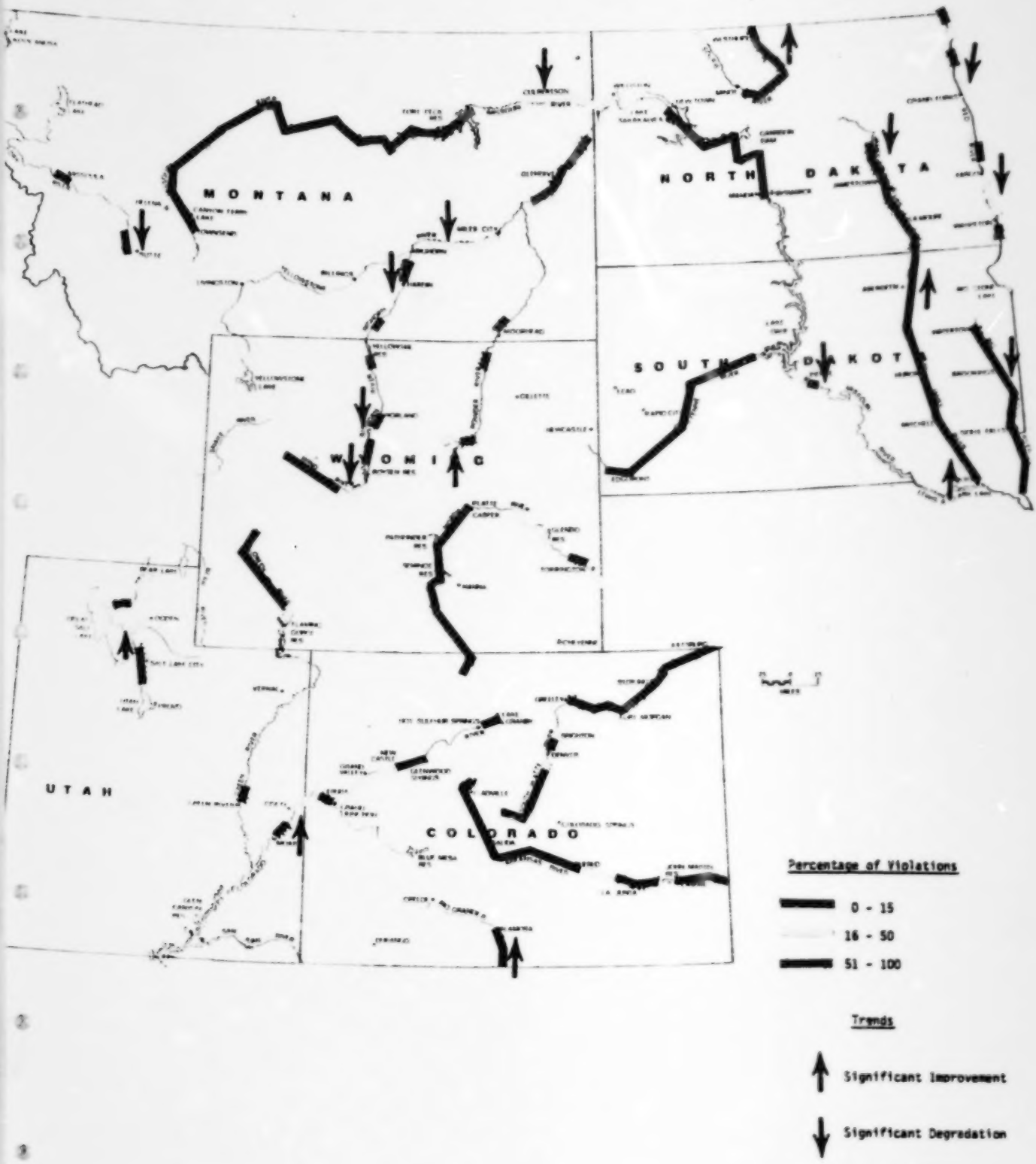

Figure 5. Standards/Criteria Violations -- Total Dissolved Solids (TDS).

Group Summary as a Water Quality Index

The rationale for the index derivation is discussed in a separate section. The water quality index actually represents the product of the percentages of violations for the five pollutant groups that were previously discussed. A map illustrating index values for the Regional Waters is shown in Figure 6.

The range of index values utilized in developing the descriptive map is as follows:

0-5	Infrequent water quality problems
5-15	Intermediate and/or intermittent water quality problems
15-100	Significant water quality problems

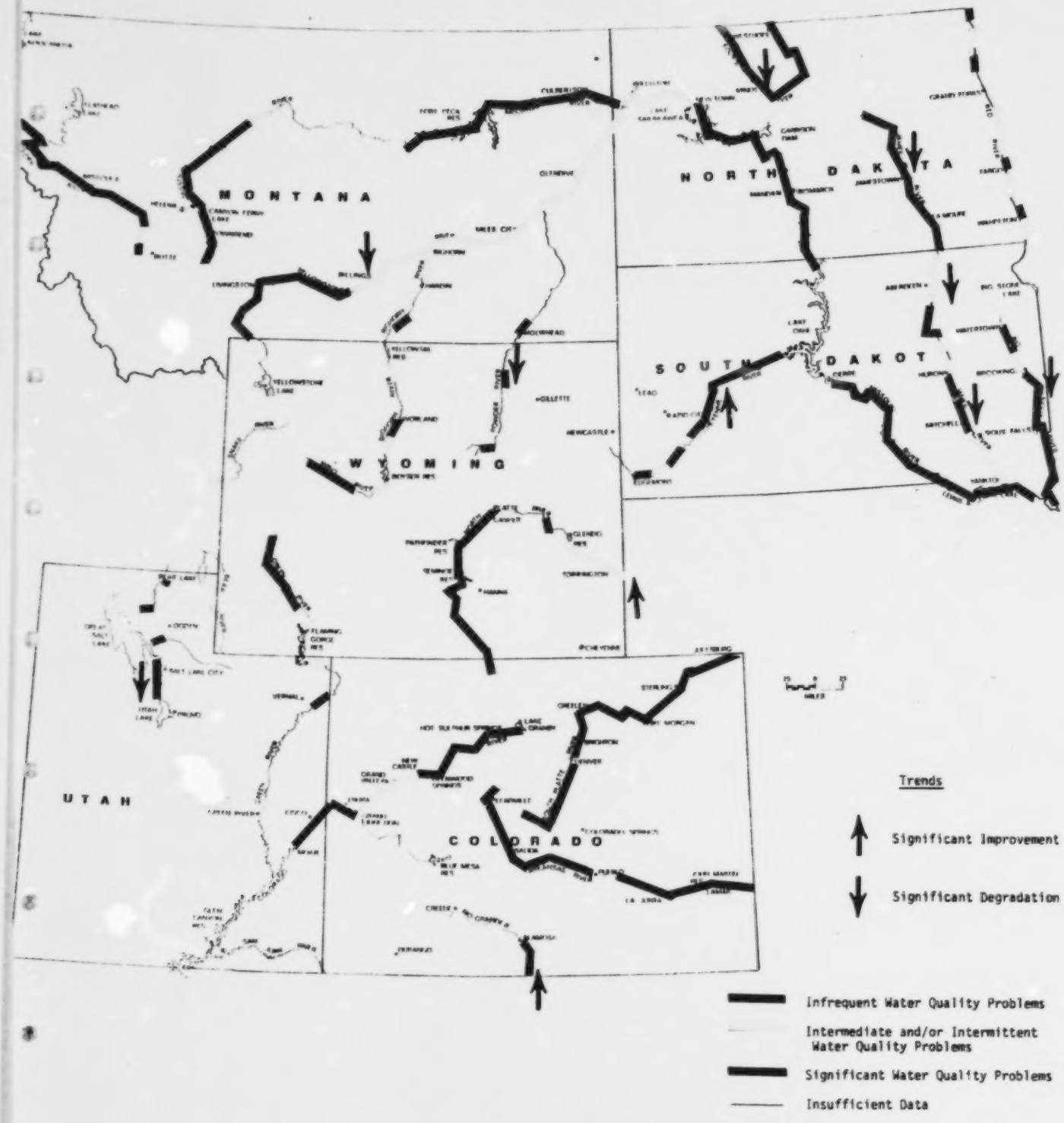

Figure 6. Water Quality of Major Streams in Region VIII.

DESCRIPTION OF THE WATER QUALITY INDEX

The Region VIII Water Quality Index was developed primarily in response to the water quality assessment requirements placed upon the region by Section 305(b) of P.L. 92-500. This index utilizes some of the conceptual ideas developed by (1) The National Sanitation Foundation (NSF) for its Water Quality Index used in the publication "Water Quality Index Application in the Kansas River Basin" and (2) EPA's Region X in its "Water Quality Index." These concepts tempered with experience and knowledge of the geography, geology, hydrology and land use in Region VIII allowed the emergence of a simple, easily understood method for qualifying regional streams which also considered the regions unique water data characteristics.

Rationale for Parameter Group Selection and Equal Weighting

After examining several indexing systems the idea of giving equal weights to each of 4 parameter groups was adopted. Weights developed for the NSF index were used as a reference for the equal weight assignments.

Group 1, the oxygen related group, consists of D.O. and BOD which have NSP weights of (0.17) and (0.11) respectively for a group total of (0.28). This weight was reduced to (0.25) for Region VIII's use since few D.O. and BOD violations occur in the main stems monitored by fixed sampling stations.

Group 2, consists of total coliform (0.0) and fecal coliform (0.16) with a combined NSF weighting of (0.16). This weighting was considered to be much too low for the Region Index since total coliform, a significant indicator for both point and nonpoint sources was completely neglected in the NSF assessment. Group 2 is weighted at (0.25).

It was felt that Group 3, consisting of nitrogen (0.10) and phosphorus (0.10) was weighted low. Since the nutrient problem is a function of the availability of both Nitrogen and Phosphorus they were weighted equally at (0.125). The NSF Group 3 total weight was raised to (0.25) because of the over abundance of natural phosphorus and nitrogen in this region and due to the National Water Quality Assessment of 1972, highlighting nutrient enrichment as the number one water quality problem.

Group 4, a combination of total solids and turbidity, represented by NSF weights of (0.07) and (0.08) respectively, was considered as being weighted too low at (0.15). These parameters are related to a number of different land use practices which are not readily resolvable and apparently are worsening year by year. The Group 4 weight was raised to (0.25).

Index Calculations

After screening the data for outlying values and attempting to rectify other data discrepancies that are obvious and immediately recognizable, the percentage of criteria or standards violations of each group is calculated. These values are then raised to the even weighted 0.25 power from which a single product, the Water Quality Index, was computed.

$$\left[\begin{matrix}\text{(\% violations)}\\ \text{DO + BOD}\end{matrix}\right]^{.25} * \left[\begin{matrix}\text{(\% violations)}\\ \text{BAC-T}\end{matrix}\right]^{.25} * \left[\begin{matrix}\text{(\% violations)}\\ \text{NITROGEN}\end{matrix}\right]^{.125} * \left[\begin{matrix}\text{(\% violations)}\\ \text{PHOSPHORUS}\end{matrix}\right]^{.125} * \left[\begin{matrix}\text{(\% violations)}\\ \text{TDS + TURBIDITY}\end{matrix}\right]^{.25} = \text{WATER QUALITY INDEX}$$

Since each group expressed as a percentage must range from 0-100 and the sum of the fractional exponents is 1 the WQI must have a value from 1 (best) to 100 (worst).

If a group violation percentage was less than 1, or if it had no violations, it was set to 1 to prevent the group product from being less than 1.

Roughly, a Water Quality Index of 10 corresponds to a station where violation of state standards or criteria occurs 10 percent of the time in each group.

BASIN DISCUSSIONS

Discussions of the analytical results obtained for each of the principal streams in the Region are contained in this section according to State and in alphabetic order.

The discussion treats individual stream pollutants in each first and then an aggregate of these pollutants is computed as the water quality index. Trends in the data are discussed whenever appropriate.

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ARKANSAS RIVER

COLORADO

Reach	Use	Classification
1. Headwaters to Canon City, Colorado	Unlimited Man Cold Water Fish	B-1
2. Canon City, Colorado to CO.-KS. state line	Unlimited Man Warm Water Fish	B-2

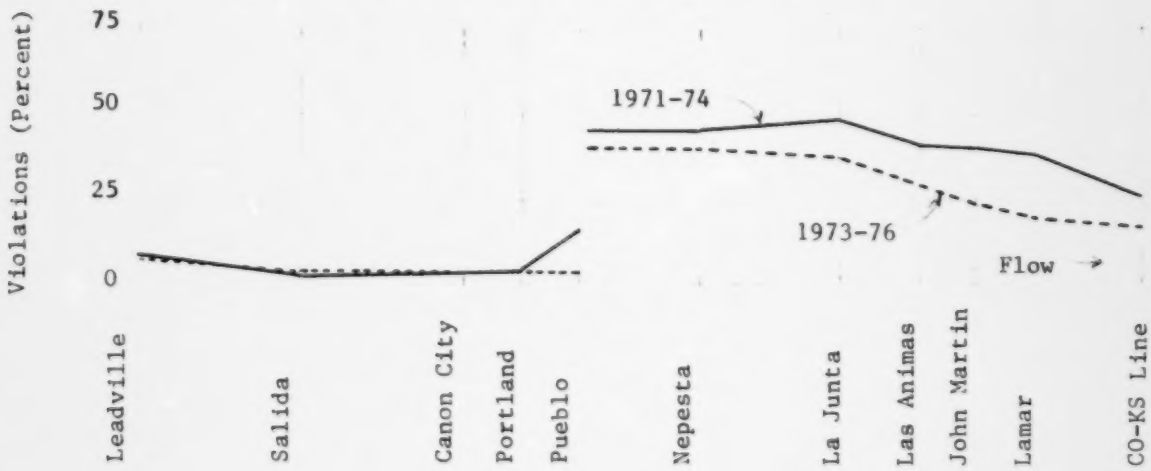
Group Analysis

Oxygen Related Group

Violations were only evident at the Nepesta station where 3 violations were noted in 178 observations.

Bacteria

Significant violations of this group appeared at the Nepesta station. Although this station is forty miles downstream from the City of Pueblo, Colorado, the City is probably responsible for the violations. Substantial improvement is noted for the latter time period (see graph below), which can probably be credited to the NPDES Program.



Nitrogen

The percentage of violations above Pueblo, Colorado, were 25 percent, but at the Nepesta station and downstream to the Colorado-Kansas state line the violations were about 98 percent. The municipal wastewater treatment facility at Pueblo probably starts off the high loading. Other towns and agricultural activities do their share to sustain this load. No trends were discernible.

Phosphorus

Phosphorus violations at the Nepesta station were about 95 percent. Upstream and downstream from this point the violations were between 40 and 70 percent. The most significant change noted for the two time periods was the decrease of violations from 79 percent to 37 percent recorded at the Salida station.

TDS

Violations in this group ranges between 40 percent to 97 percent for the segment between Nepesta and the Colorado-Kansas state line. A 6 percent decrease in violations were noted for the latter time period.

Other

The presence of total iron, manganese and zinc in the river were noted at the first station near the headwaters (below Leadville). The concentrations (µg/l) were:

	Fe total	Mn total	Zn total
Violations	9	12	12
Observations	15	13	13
Minimum	40	0	0
Mean	573	234	557
Maximum	1000	610	1200

The concentrations diminish a small amount downstream but rise again near the Town of Portland. The maximum total iron concentration at the Colorado-Kansas state line was 7700 mg/l.

Index Analysis

The index values above the City of Pueblo, Colorado, were less than 4. Below the station at Nepesta and all the way downstream to the Colorado-Kansas state line the values were about 20. Generally, the index values for the latter time period were about 10 percent lower than for the first time period.

COLORADO RIVER

COLORADO

Reach	Use	Classification
1. Headwaters to Grand Valley, Colorado	Unlimited Man Cold Water Fishery	B-1
2. Grand Valley, Colorado to CO.-UT. state line	Unlimited Man Warm Water Fishery	B-2

Group Analysis

Oxygen Related Group

No violations were observed.

Bacteria

Percentage of violations of 18 percent and 23 percent were observed at Fruita, Colorado and Loma, Colorado, respectively for the latter time period. These violations can only be associated with discharges from the municipal and wastewater treatment facilities. The above violations were a change of 40 percent less than observed for the first period.

Nitrogen

For the latter time period, the percentage violations above Grand Junction, Colorado, were about 7 percent, but at Fruita, Colorado, the violations were 65 percent. Causes of this load can be to some extent attributed to the municipal wastewater treatment plants from the various towns. Although this section includes the Grand Valley where there is extensive irrigation for orchards, it does not seem that applied fertilizers would contribute as heavily to the nitrogen load as would be expected for the South Platte and

and Arkansas basins, but the results appears to be about the same. The Gunnison River also joins the Colorado River at Grand Junction and this tributary carries a significant nitrogen load.

Phosphorus Related Group

Violations for this group were first apparent at the Hot Sulphur Springs station. This station is located about 20 miles downstream from the headwaters. There were 23 Ortho PO_4 violations per 45 observations. Downstream from this station the percentage of violations fluctuated between 14 percent and 87 percent.

Index Analysis

The index values for the latter time period were 16 percent less than the values for the first time period.

TDS

The appearance of high TDS concentrations became noticeable in the index at the state's Dotsero station. The concentrations continue to rise downstream. The statistics for the state station at Loma were 283 mg/l minimum, 783 mg/l mean, and 1442 mg/l maximum.

Index Analysis

The index values for the segment above Dotsero Springs, Colorado, were below 3, but the values were from 26 to 45 percent higher for the latter time period. At New Castle, Colorado, the index was 9. No trends could be determined for the river below Dotsero Springs because some stations would show improvement whereas the next station downstream would show degradation.

RIO GRANDE RIVER

COLORADO

Reach	Use	Classification
1. Headwaters to CO.-NM. state line	Unlimited Man Cold Water Fish	B-1

Group Analysis

Oxygen Related Group

At the Lobatos, Colorado station, 4 percent violations (2 violations per 57 observations) were noted for the first time period but no violations occurred during the latter time period.

Bacteria Related Group

The largest number of violations noted were observed by the State at their Manassa station where 6 violations per 50 observations (12 percent) were recorded for both time periods. The City of Alamosa and other communities may be the source of this load although the concentrations are comparatively low (697 mpn/100 ml mean and 4600 mpn/100 ml maximum).

Nitrogen Related Group

The violations noted at Alamosa and the downstream stations vary between 1 percent and 10 percent. The USGS noted one violation of NO_2+NO_3 in 21 observations at their Lobatos station.

Phosphorus Related Group

High percentage violations occurred at all the water quality stations in the valley. The average was 90 percent. It appears that the phosphorus

load was initially picked up near the headwaters and the load is being carried downstream.

Physical Related Group

The only item of note is the decrease in the percentage of violations from 10 percent to 1 percent for the two respective time periods. The mean TDS concentrations at Lobatos was 194 mg/l and the maximum recorded was 338 mg/l.

Other

Extensive mining activities occur in the San Juan Mountains. Hence, the influence of this area on the river is evident because of the presence of trace metals in the analyzed samples. Some concentrations (µg/l) noted are as follows:

	Cd total	Fe total	Hg. diss.	Hg total	Mn diss.	Pb total
Violations	6	8	2	2	4	7
Observations	8	8	8	8	16	8
Minimum	0	340	0.0	0.0	0	5
Mean	8	980	0.17	0.29	41	88
Maximum	10	2500	1.00	1.70	130	100

Index Analysis

An index value of less than 5 was calculated for portions of the Rio Grande River below Alamosa, Colorado. Insufficient data above this station did not permit the calculations of an index number for the upper segment of the river.

SOUTH PLATTE RIVER

COLORADO

Reach	Use	Classification
1. Fairplay, Colorado to Exposition Avenue, (Denver, Colorado)	Unlimited Man Cold Water Fish	B-1
2. Exposition Avenue, (Denver, Colorado) to CO.-NB. state line	Unlimited Man Warm Water Fish	B-2

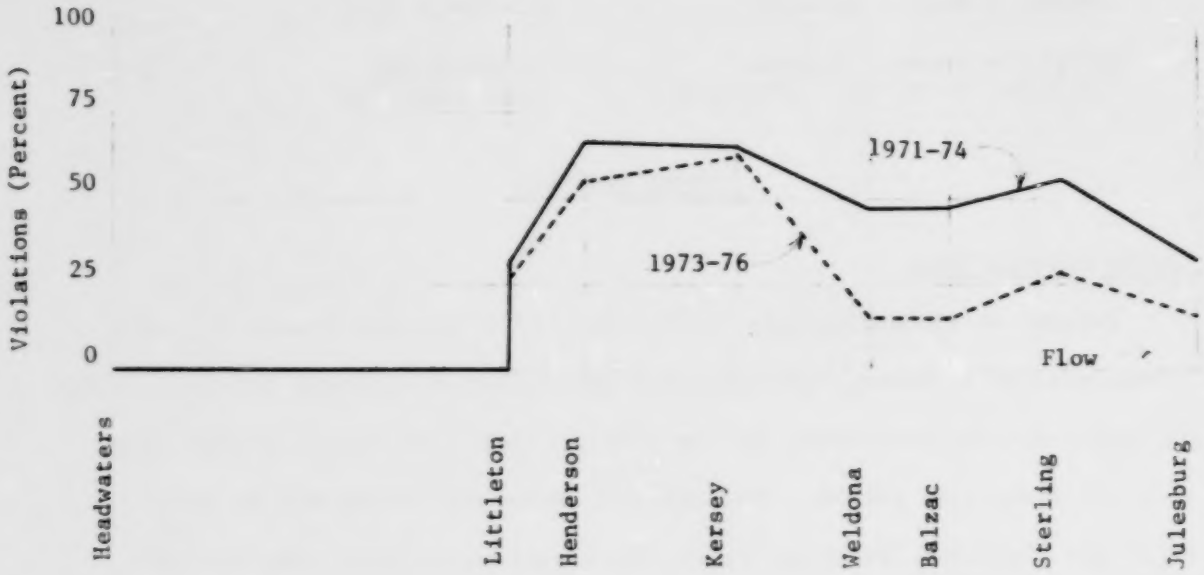
Group Analysis

Oxygen Related Group

Percent of violations were in the order of 40 percent between the 88th Avenue station in Denver, Colorado, and the Henderson, Colorado station. Within this reach the violations for the latter time period were 5 percent lower than the first time period. The USGS continuous monitoring station at Henderson, recorded Dissolved Oxygen concentrations dropped below 5.0 mg/l almost every day of the year. Violations for the remainder of the river never exceeded 2 percent.

Bacteria

The percentage of violations for the main-stem are shown in the graph below.



The violations begin with the municipal wastewater treatment plants located in the southern edge of the Denver metropolitan area. These violations are further sustained all the way downstream from sources such as "liquid manure" applied to fields for fertilizers and the numerous feedlots located along the river. The graph for the latter time period could indicate an improvement due to the impact of the NPDES permit program.

Nitrogen

High violations in the order of 78 percent were first noticed at the Dartmouth Avenue Station in Denver, Colorado. The percentage of violations increased to 97 percent and remained at that level all the way to Sterling

where the percentages dropped to 76 percent. From where the violations first became noticeable the cause is pointed to the municipal wastewater treatment plants beginning at Littleton, Colorado. Fertilizers, especially the manure applied to the fields from the numerous feedlots, have to be responsible for much of this nitrogen load. The overall improvement in trend varied between 2 and 9 percent reduction in violations.

Phosphorus

Violations for the segment from Littleton, Colorado, to the Colorado-Nebraska state line were about 100 percent for the two time periods.

TDS and Turbidity

Violations for this group were between 60 and 70 percent between Denver and the Colorado-Nebraska state line. No violations were observed above Denver.

Index Analysis

Index values for the segment above the City of Littleton, Colorado, were 3.5 and 2.5 for the two time periods. Downstream, from this station to the Colorado-Nebraska state line, the index values were over 20. The maximum value was 62 at the 124th Avenue station in Denver. The overall index values for the latter time period were about 5 percent lower than the first time period.

BIG HORN RIVER

MONTANA

Reach	Use	Classification
1. Wyoming Border to Williams Coulee below Hardin	Unlimited Man Cold Water Fishery	B,D1
2. Williams Coulee below Hardin to the Yellowstone River	Unlimited Man Cold Water Fishery	B,D2

Group Analysis

Oxygen Related Constituents

No violations were observed for either period at any point in either reach.

Bacteria (fecal and total)

A bacteria violation percentage of 7 percent was observed along both reaches for the second period. The Hardin station showed an improvement in bacterial quality by a decrease from 20 percent to 7 percent violations between the two periods.

Nitrogen

No nitrogen violations were observed for either period at any station along both reaches except for 3 violations out of 58 samples for the second period at the St. Xavier station.

Phosphorus

Phosphorus violations for both reaches rose from 35 percent for the

first period to 46 percent during the second period. The Big Horn station showed a major decline in phosphorus quality indicated by an increase of violations from 27 percent for the first period to 59 percent for the second period.

TDS-Turbidity

Overall TDS-turbidity violations decreased from 80 percent for the first period to 60 percent for the second period. The Big Horn station had violations of 50 percent for both periods. This was the lowest percentage of violation along either reach.

Other

Heavy metals samples showed a high percent of violations at Big Horn, Montana. Only a small amount of heavy metal samples were taken at Big Horn during the first period. During the second period, samples were numerous and indicated cadmium had a 44 percentage of violations and zinc 32 percent.

Probable Causes

Irrigation uses in Wyoming and Montana affect water quality as well as Big Horn Lake (an upstream reservoir).

Index Analysis

The index decreased slightly from 9 to 8 for the two periods. This would indicate that the quality had no major change. Due to the lack of data at the St. Xavier station the quality effect of water coming from Yellowstone Reservoir could not be ascertained. The Big Horn station just upstream of the confluence bith the Yellowstone River showed some decline in quality (4 to 7 index).

CLARK FORK RIVER

MONTANA

Reach	Use	Classification
1. Warm Springs Creek to Cottonwood Creek	Limited Man Cold Water Fishery	C,D2
2. Cottonwood Creek to the Little Blackfoot River	Limited Man Cold Water Fishery	C,D1
3. Little Blackfoot River to the Idaho Border	Unlimited Man Cold Water Fishery	B,D1

Group Analysis

Oxygen Related Constituents

No violations of the oxygen parameters were observed for either period along the three reaches.

Bacteria (fecal and total)

Bacteria violations for the upper segment (Galen-Deer Lodge) of Reach 1 became higher between the first and second period (21 percent to 30 percent). Progressing down the river the quality continued to improve till it reached a no violation level at Thompson Falls.

Nitrogen

Violations for the Galen-Deer Lodge segment of Reach 1 increased at both the Galen and Deer Lodge stations for the two time periods. Galen had a rise from 8 percent violations to 17 percent violations and Deer Lodge had no violations for the first period with 10 percent violations for the second period.

Phosphorus

Phosphorus violations decreased at all the stations along the reaches from the first to the second period. The violations became less numerous progressing downstream from Galen. The violation percentage was from a high of 83 percent for the last period at Galen to a low of 50 percent for the last period at Thompson Falls.

TDS-Turbidity

Quality was noted to improve progessively downstream from Galen. Galen had 100 percent violations, Deer Lodge 56 percent and the Missoula-Thompson Falls segment of Reach 2 had no violations for the last period. A major decline in TDS-turbidity quality occurred between the periods at Galen, 61 percent to 100 percent violations.

Other

Numerous heavy metal violations occurred in all the reaches during the first period but no heavy metal samples were taken during the second period.

Probable Causes

Copper mining and refining activities at Butte and Anaconda contribute to the metals problems in the upper portion of Reach 1. Inactive mines in that area also add to the metal and TDS violations. Major STP's probably cause the bacteria problems at Galen and Deer Lodge.

Index Analysis

The upstream area consisting of Galen and Deer Lodge stations (Reach 1) has considerable more violations than the downstream segment (Reaches 2 and 3) from Missoula to the Idaho border. The overall index rose from 13 for the first period to 19 in the second period for the Galen-Deer Lodge segment of Reach 1. For the same time period, the index for the Missoula-Thompson Falls segment (Reaches 2 and 3) remained low. An index of 3 for both periods was calculated for this segment.

MISSOURI RIVER

MONTANA

Reach	Use	Classification
1. Headwaters to the Sun River	Unlimited Man Cold Water Fishery	B,D1
2. Rainbow Dam to Fort Peck	Unlimited Man Cold Water Fishery	B,D3
3. Fort Peck to the Milk River	Unlimited Man Cold Water Fishery	B,D2
4. Milk River to the North Dakota Border	Unlimited Man Cold Water Fishery	B,D3

Group Analysis

Oxygen Related Constituents

No violation in oxygen criterion was noted in any of the reaches.

Bacteria (fecal and total)

The segment of Reach 1 between the headwaters and Townsend showed a slight increase in violations (4 to 8 percent). Only at the Fort Benton station was a sizeable improvement in water quality noted. The percentages of violation went from 36 to 11 percent between the periods. No violation occurred at/or downstream of Zortman for reaches 2, 3 and 4.

Nitrogen

Nitrogen violations were noted only from the headwaters to Zortman and these were no greater than 7 percent for either time period and any station in the reaches. No violations occurred in Reaches 3 and 4 from Fort Peck to the Montana-North Dakota border.

Phosphorus

Phosphorus violations remained constant for the two periods. From the headwaters to Fort Benton the percentages of violation were from 85 to 100 percent. In the portion of the river from Zortman to Fort Peck the violations dropped drastically to less than 10 percent. Then the violations rose steadily in the portion of the river from Fort Peck Dam to the Montana-North Dakota border. At Culbertson, near the Montana-North Dakota border, it had risen to 65 percent.

TDS-Turbidity

TDS violations were not greater than 7 percent for Reaches 1 and 2. These reaches extend from the headwaters to below Fort Peck Dam. However, at Culbertson the percentages of violation rose to 24 percent for the second period.

Other

The heavy metals, consisting of cadmium, zinc, lead and manganese, showed violations which occurred intermittently for both time periods at several stations along all the reaches. These violations were as high as 45 percent for some of the metals at several stations.

Probable Causes

Abondoned mines in Reach 1 can cause some of the severe metal problems. Industrial, irrigation, and municipal uses in the Great Falls-Fort Benton portion of the river account for the water quality being slightly poorer than the quality of water in the downstream areas of the reaches.

Index Analysis

The index values for both periods remained low. The general index range was from 1 to 6. Only the part of the river from the headwaters to Fort Benton had an index value as high as 6.

POWDER RIVER

MONTANA

Reach	Use	Classification
1. Wyoming Border to the Yellowstone River	Unlimited Man Cold Water Fishery	B,D3

Group Analysis

Oxygen Related Constituents

The oxygen violation percentage remained the same for both periods at less than 2 percent.

Bacteria (fecal and total)

Bacteria violations for the first period amounted to 21 percent. No bacteriological samples were taken the second period.

Nitrogen

Nitrogen violations remained the same for both periods at 9 percent.

Phosphorus

Phosphorus violations declined slightly from 100 percent in the first period to 89 percent in the second period.

TDS-Turbidity

TDS-turbidity violations for the reach declined slightly between the two periods. (100 percent to 88 percent).

Other

Heavy metals were high and in most cases showed an increasing percent

of violations from period one to period two. Cadmium went from 0 to 90 percent violations, lead 4 to 67 percent and zinc 21 to 56 percent. Mercury violations remain high at 50 percent.

Probable Causes

Natural runoff and irrigation diversion appear to be the major factors influencing violations.

Index Analysis

Only one station, at Moorhead, was monitored within this reach. The index dropped from 13 to 7 but no bacteriological data were present in the second period. This biases the index to a lower value. Had the bacteria violations for the second period been the same percent as the first period, the index would be 16. This suggests little improvement occurred in quality between the periods.

YELLOWSTONE RIVER

MONTANA

Reach	Use	Classification
1. Yellowstone Park to Laurel WTP	Unlimited Man Cold Water Fishery	B,D1
2. Laurel WTP to Billings WTP	Unlimited Man Cold Water Fishery	B,D2
3. Billings WTP to North Dakota Border	Unlimited Man Cold Water Fishery	B,D3

Group Analysis

Oxygen Related Constituents

No violations were observed for either period. The range of dissolved oxygen was from 7 to 13.

Bacteria (fecal and total)

The segment upstream of the Laurel WTP station (Reach 1) showed a decrease in violations from 23 percent the first period to 17 percent the second period. However, the segment downstream of Billings (Reach 3) showed an increase from 33 percent to 41 percent violations between the periods. The Huntley station, approximately 10 miles downstream of Billings showed an increase of violations from 65 to 84 percent between the two periods. This rate decreased downstream till it reached less than 15 percent violations at Sydney.

Nitrogen

Nitrogen violations for both periods were from 0 to 5 percent along all

the reaches except for the station at Billings. This station showed a higher number of violations (16 percent for both periods).

Phosphorus

In a fashion similar to the bacteria violations in the reaches, a violation decrease from 59 percent the first period to 40 percent the second period was noted in Reach 1 at and above the Laurel WTP. Reach 3, below the Billings WTP, showed a sizeable increase in violations from 53 percent the first period to 74 percent the second period. At Corwin Springs 85 percent violations occurred, possibly due to natural sources at Yellowstone Lake. Billings and Miles City had a significant rise in violations. The two time periods showed a violation increase from 32 to 48 percent violations for Billings and 34 to 57 percent violations for Miles City.

TDS-Turbidity

The overall TDS-turbidity violation percentages remained almost the same for both time periods. Violations of less than 15 percent occurred in Reach 1, Reach 2 and the portion of Reach 3 upstream of the confluence with the Big Horn River. Downstream the violations rose to 35 percent. The Big Horn River had TDS-turbidity violations of greater than 50 percent. The Powder River, which had violations over 50 percent, causes the violations downstream of the confluence with the Yellowstone to rise to 57 percent for the second period.

Other

Heavy metal violations occurred for both time periods in Reach 3, the part of the river from Billings to the Montana-North Dakota border.

The two metals with the highest violations (lead and zinc) have shown a decline in violation percentages from the first to second period. Lead violations dropped from 72 to 55 percent and zinc declined from 62 to 34 percent between the periods. The violations seemed to occur more frequently in the Billings area but they did extend as far downstream as Sydney, Montana.

Probable Causes

The quality of the Yellowstone River at and downstream of Billings is affected by two oil refineries, a sugar refinery, two STP's and a power plant. Irrigation diversions influenced the quality along the entire reach. As indicated earlier the inflows of the Powder and Bighorn Rivers affect the water quality of the Yellowstone.

Index Analysis

The index changed very little between the periods. Reach 1 from Yellowstone Park to the Laurel WTP had an index decrease of 1 (6 to 5). Reach 3, from the Billings WTP to the Montana-North Dakota border has an index of 12 for both periods. The Billings station showed a noticeable index increase from the first period to the second period. This was caused by increased violations of bacteria, phosphorus and TDS-turbidity criteria.

JAMES RIVER

NORTH DAKOTA

Reach	Use	Classification
1. Headwaters to the North Dakota-South Dakota Border	Limited Man Native Fish	IA

Group Analysis

Oxygen Related Constituents

The overall percentage of violations rose from 4 percent to 6 percent over the two periods. The greatest increases between periods were at Edmunds and Oakes, (23 to 50 percent and 6 to 19 percent respectively). The middle section of the river (Jamestown and Lawrence) had no violations.

Bacteria (fecal and total)

Bacterial violations for the reach decreased slightly (31 to 27 percent). Despite the fact that the Jamestown stations showed a drop in violations (34 to 21 percent), all the other stations showed an increase, from 8 to 22 percent.

Nitrogen

Nitrogen samples were taken only at the two stations on the downstream portion of the reach (Lawrence and Oakes). The violations remained approximately the same, varying only from 10 to 15 percent for both periods at both stations.

Phosphorus

Phosphorus violations were close to 100 percent for the reach during both time periods.

TDS-Turbidity

TDS and turbidity violations in the reach remained approximately the same, at 70 percent for both periods.

Other

Manganese violations from 80 to 85 percent were noted at Jamestown and further downstream at Lawrence for both periods.

Probable Causes

Frequent low flow conditions along with agricultural and municipal diversions and nonpoint sources created the high TDS violation percentage. Naturally occurring phosphorus accounted for the high phosphorus levels.

Index Analysis

The overall index showed an increase (24 to 26) between the two time periods, indicating some deterioration in quality. However, the Edmunds station (farthest upstream) and the Oakes station (farthest downstream) showed marked index increases. Edmunds increased from 24 to 36 and Oakes increased from 17 to 34 between the two periods. Moving from upstream to downstream for the last period, Edmunds had an index value of 35. The index was 11 at Jamestown and began to rise again until it reached 34 at Oakes.

MISSOURI RIVER

NORTH DAKOTA

Reach	Use	Classification
1. Montana-North Dakota Border to North Dakota-South Dakota Border	Unlimited Man Native Fish	I

Group Analysis

Oxygen Related Constituents

No oxygen violations occurred in either period at any station along the reach.

Bacteria (fecal and total)

Bacteria violations decreased from 12 percent for the first period to 5 percent for the second period. The only area of significant increase was at Williston where 3 percent violations were noted the first period and 12 percent the second.

Nitrogen

Only one to 2 percent violations were noted for the entire reach.

Phosphorus

Violations of phosphorus criteria for the reach remained the same for both periods at 44 percent. Only at Garrison Dam and Bismarck was an improvement in quality noted. Garrison Dam violations declined from 24 percent to 18 percent and Bismarck violations also declined from 55 percent to 42 percent violations between the two periods.

TDS-Turbidity

TDS and turbidity violations for the reach increased from 5 percent to 9 percent from one period to the next. The Williston station samples indicated a drastic rise in violations (12 to 42 percent). The other stations in the reach were relatively stable in violation percentages.

Other

The segment from Williston to Garrison Dam is plagued with intermittent heavy metal problems. Cadmium above 80 percent, zinc above 50 percent and mercury above 40 percent occurred in both periods. Manganese showed a drastic violation increase from 0 to 32 percent over the two periods.

Probable Causes

The influence of the Yellowstone River above Williston is a probable cause of the high metals violation ratings extending from Williston to Garrison Dam. Phosphorus occurs naturally in this reach.

Index Analysis

The Missouri River index has remained very good throughout both periods (4 and 2). A value of approximately 8 for both periods occurs at Williston apparently because the Yellowstone River merges with the Missouri just upstream of Williston. Beside the index of 8 at Williston, only at Bismarck does the overall index rise as high as 5.

RED RIVER OF THE NORTH

NORTH DAKOTA

Reach	Use	Classification
1. Wahpeton to the Canadian Border	Unlimited Man Native Fish	I

Group Analysis

Oxygen Related Constituents

Oxygen violations for the reach increased only slightly during the two periods (1 percent to 3 percent). The quality from an oxygen standpoint is still very good.

Bacterial (fecal and total)

Bacteria violations decreased from the first to the second period (39 to 33 percent). The only two areas having major problems are Fargo and Oslo. Both have 60 to 65 percent violations with no sign of decreasing violations with time.

Nitrogen

Nitrogen violations showed a slight increase between periods (16 to 19 percent). Almost every station showed some increase. Violations were low (below 15 percent) from Fairmont to Fargo. At and below Fargo, the violation percent rose and then dropped again at all the stations below Grand Forks.

Phosphorus

Phosphorus violations were 95 to 100 percent along the entire reach

except at and upstream of Wahpeton, where the violation rate was 85 percent.

TDS-Turbidity

Measurements for TDS and turbidity showed a marked increase in violation percent, (18 to 27 percent). A significant rise in violations was shown downstream of Grand Forks and Oslo.

Other

Heavy metal violations were prevalent along the entire river with no sign of improvement between the time periods. Cadmium and manganese are the prime violators with 98 percent and 90 percent violations.

Probable Causes

Several sugar refineries, major STP's and major power plants degrade this river. Low flow conditions and agricultural runoff also causes some of the violations. Phosphorus occurs naturally which makes the percent of violations close to 100.

Index Analysis

The overall index values shows an increase from 13 to 18 from the first to second periods. In most of the stations at Grand Forks and upstream, the quality is improving. Below Grand Forks the quality becomes worse between the two time periods.

SOURIS RIVER

NORTH DAKOTA

Reach	Use	Classification
1. Canadian Border to Canadian Border	Limited Man Native Fish	IA

Group Analysis

Oxygen Related Constituents

The percent of oxygen related constituent violations for the reach rose slightly between the two periods (10 to 14 percent). Upstream of Minot, the violations remained constant at less than 15 percent but, downstream of Minot to the Canadian border the violations for the second period were greater than the first period violations (11 to 15).

Bacteria (fecal and total)

Bacteria violations rose from 10 to 15 percent between the two periods. This is almost exactly the same violation percentages noted for oxygen related constituents. The major bacterial degradation was at Sawyer, which is below Minot (4 percent to 26 percent).

Nitrogen

Violations of the nitrogen parameters rose 50 percent (8 to 12 percent) between the two periods. Sherwood (near the Canadian border) had 11 percent and 24 percent violations during the two periods. The only other major degradation in nitrogen was noted at Minot (7 to 38 percent).

Phosphorus

Phosphorus violations remained constant for both periods averaging about 95 percent. Only at Minot was a major degradation noted (44 to 100 percent). All the other stations had an initially high violations rate which continued in the second period.

TDS-Turbidity

TDS and turbidity violations in the reach dropped considerably (62 to 49 percent). An improvement in quality occurred at almost all the stations examined.

Other

pH violations were noted 3 to 5 percent of the time for both periods at most stations. Cadmium, manganese, mercury, lead and zinc violations were prevalent. The highest percentages of violation were for cadmium and manganese with 95 and 74 for the last period.

Probable Causes

Naturally occurring phosphorus accounts for some of the high phosphorus violations. Oxygen and nitrogen problems at and below Minot are probably caused by the STP's and municipal runoff from the Minot area.

Index Analysis

The index value increased slightly (20 to 24) between the two periods indicating some degradation in the water quality. The index at Sherwood, near the Canadian border, rose from 22 to 28. The water coming from Canada showed an increase in violations between periods. Violations in

water flowing back into Canada, measured at the two Westhope stations, also increased (16 to 23 percent). Based on violations observed, water flowing into Canada appears to be of higher quality than that flowing from Canada in both time periods.

BIG SIOUX RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. Headwaters to the Diversion Canal at Sioux Falls	Limited Man Warm Water Fishery	1,5,8,9,10,11

Group Analysis

Oxygen Related Index (D.O. and BOD)

During the first period of record only one D.O. violation was recorded in the total reach. The Dissolved Oxygen violations increased to 8 percent during the second period with the major concentrations occurring between the headwaters and the Brookings, South Dakota station. Presumably part of this change is due to seasonal recording differences at low flows and pooled conditions when considerable organic nutrients were present.

Bacteria Related Index (fecal and total)

The high bacteria violations which contribute to the Quality Index for this stream segment have remained essentially constant showing no improvement over the two periods of study with an average near 22 percent. This problem is probably related to the increased oxygen and nutrient problems.

Nitrogen

The percentage of nitrogen violations increased markedly from the first to second time period in a consistent manner all along this stream segment. Forty-seven percent (47) violations in 1971-1974 to 65 percent violations in 1973-1976.

Phosphorus

Phosphorus violations remained at approximately 100 percent throughout both time periods. This seems to be due primarily to nonpoint phenomena stemming from natural phosphates in the soil.

TDS and Turbidity

Little change noted over the two time periods in TDS and turbidity parameters. Violations are consistently observed in the 72 percent range. Maximum values for TDS range from 1008 mg/l in the first period to 4501 mg/l in the second period.

Other

Temperature and pH violations are nonexistent in the segment but there are numerous zinc, lead and manganese criteria violations.

Probable Causes

There exists frequent near no flow and pooled water conditions. Concentrations of ammonia and nitrates are the result of decomposition of animal wastes in runoff from pastures and cultivated fields. A major sand and gravel plant, a rock quarry and crushing operation and three sewage treatment plants are in this reach.

Index Analysis

Index values calculated show a marked increase for the second time period over the entire length of the reach (19 vs 31). That portion of the stream at and above Watertown contributed most of to this increase. The index for

the Brookings and for the Dell Rapids station continued to show generally poor water quality. Both time periods have sufficient data available to allow the assumption that the index is reflecting the existing stream quality.

BIG SIOUX RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. Sioux Falls Diversion Canal to Klondike Dam	Limited Man Warm Water Fishery	5,8,9,10,11
2. Klondike Dam to the Iowa Border	Limited Man Warm Water Fishery	4,7,8,9,10,11

Group Analysis

Oxygen Related Constituents (DO and BOD)

Dissolved oxygen violations in this segment increased from 8 percent in the first time period to 10 percent in the second time period with 70 percent of all observed violations occurring in the stretch below Brandon, South Dakota.

Bacteria (fecal and total)

Bacteria violations were reduced nearly in half over the two time periods. Approximately 71 percent violations occurred in time period 1 as compared to 37 percent violations in time period 2. This reduction seems to be fairly uniform over all sampling stations in this segment.

Nitrogen

Nitrogen violations doubled over the two periods of study, the largest increase being noted at stations immediately downstream of Sioux Falls.

Phosphorus

No noticeable change is observed in phosphorus standards violations over

the two time periods. Violations occurring at all sampling stations in the segment are practically 100 percent. Perhaps a seasonal breakdown of the data could pinpoint and differentiate those areas affected by contributions from municipalities and from natural sources.

TDS and Turbidity

Violations of the TDS standards remain at the 75 percent level during both time periods. Chloride and sulfate violations approach 50 percent. Chlorides seem to show a marked increase below the Sioux Falls plant during the second time period. This along with the decrease of bacteria in the segment is probably due to higher levels of chlorination during sewage treatment and in the winter from road salts carried by storm sewers.

Other

There were no observations of temperature or p^H violations during the first time period. Two p^H violations (9.5) were recorded in the second time period. Frequent zinc, lead, manganese and mercury violations were recorded during both time periods.

Probable Causes

The major sewage treatment plant at Sioux Falls: two meat packing plants, three power plants, urban runoff. Upstream agricultural uses.

Index Analysis

The overall index calculated for the two different time periods shows little change despite the fact that bacteria violations in the total length of

the reach have decreased and nitrogen violations have increased. It is evident that the sewage treatment plant at Sioux Falls has considerable effect on quality throughout the entire length of this segment.

CHEYENNE RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. Wyoming Border to Angostura Dam	Limited Man Warm Water Fishery	5,8,9,10,11

Group Analysis

Oxygen Related Constituents

No D.O. violations were observed during the first time period and only one violation in 57 observations was found in the second time period. There were no BOD violations in either time period.

Bacteria

Bacteria violations showed no change in Edgemont and held at 15 percent throughout both periods of this study.

Nitrogen

Percentage violations for nitrogen changed considerable over the two time periods by increasing from 13 percent to 52 percent. Most lakes in the area show advanced stages of eutrophication.

Phosphorus

Phosphorus violations showed some improvement with a decrease from 75 percent to 50 percent.

TDS and Turbidity

Measurements of TDS and turbidity violations remain at 100 percent

over the two time periods. Conductivity sulfate and chloride violations are all in the 95 to 100 percent range and show no improvement from one time period to the next.

Other

One p^H event was detected in the second time period and all 25 of the manganese observations were excessive.

CHEYENNE RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. Angostura Dam to the Fall River	Limited Man Warm Water Fishery	4,7,8,9,10,11
2. Fall River to the Missouri River	Limited Man Warm Water Fishery	5,7,8,9,10,11

Group Analysis

Oxygen Related Constituents

During each time period only one D.O. violation was recorded. BOD information is not available for any portion of this reach and there is no D.O. data for that segment immediately below the Angostura Dam and the Buffalo Gap Station.

Bacteria

Violations of criteria set for bacteria remain at approximately 28 percent throughout each time period. All of these violations occurred at the Wasta and Plainview stations. No information on bacteria is available at the upstream stations of this reach.

Nitrogen

Nitrogen violations increased from 61 percent in period one to 71 percent in period 2. Only a few of these violations (6 percent) occurred in the upper reach near the Angostura Dam.

Phosphorus

Phosphorus violations although still excessive showed some decline. Violations of 74 percent were observed during period one and 68 percent during period two. Violations of the phosphorus standard criteria were found to approach a fairly constant level throughout the reach.

TDS and Turbidity

TDS and turbidity violations were found in the 94-98 percent range during both periods. These concentrations remain constant throughout the entire reach. Excessive salinity events were observed and sulfate and conductivity violations were consistently at 100 percent.

Other

One p^H event was observed in the first time period and three in the second period. Several cadmium, lead, zinc, selenium, chromium, manganese and mercury violations were noted in both periods.

Probable Causes

- Industrial and municipal discharges at the Rapid City Power Plants near Rapid City.
- Sand and gravel washing at Hot Springs, Wasta, Sturgis, Wall and Spearfish.
- Timbering and mining activities (open pit mines and tailings dumps), agriculture (irrigation, cultivation, stock feeding).

- o Irrigation increases dissolved solids in tributaries entering this reach.
- o Bog iron in the Rapid Creek drainage.
- o Placer mining scars on French, Battle, Castle, Rapid, Bear Butte and Whitewood Creeks.
- o Home Stake Gold Mine wastes from Whitewood Creek.
- o Cement plant discharges at Rapid City.
- o Nitrogen, phosphorus, carbon, BOD, calcium, magnesium, sodium, suspended solids and other chemicals are added to all surface waters in this area from natural sources.

Index Analysis

A change in index values over the two time periods, from 26 to 23 suggests some improvement of the overall water quality in this reach. Highest violation percentages continue to occur for nitrogen, phosphorus and TDS.

JAMES RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. North Dakota Border to Huron, South Dakota	Limited Man Warm Water Fishery	5,8,9,10,11

Group Analysis

Oxygen Related Constituents

No BOD data are available in the reach and there is no DO data at Columbia. DO violations observed show little change over the two trend periods.

Bacteria (fecal and total)

Observations of bacteria violations remain at approximately 3 percent and are only recorded at Hecla and Stratford.

Nitrogen

Nitrogen violations show some slight increase over the observed time periods (49 percent - 58 percent).

Phosphorus

Phosphorus violations continue to remain at the 100 percent level for both time periods.

TDS-Turbidity

TDS and turbidity show some improvement over the trend periods with a violation percentage of 74 during time period 1 and 57 during time period 2. However, the maximum and mean observations in time period 2 exceed those in period 1.

Other

One pH violation (10.0) in 54 observations was noted in the first time period and 2 violations in 35 were found in period 2. No temperature violations were observed. Excessive manganese violations (100 percent) were observed in each period.

Probable Cause

Intermittent flows occur in the headwaters region above Huron, South Dakota. Lower stream gradient in portions of the basin often causes reverse flows in the reach. Feedlots, cultivated fields and pastures abound in the basin. Sixty-five percent of the total land in the basin is under cultivation.

Index Analysis

The index value for this stream segment shows a slight increase in the second time period suggesting some decrease in overall stream quality (16-18).

JAMES RIVER

SOUTH DAKOTA

Reach	Uses	State Classification
1. Huron, South Dakota to the Missouri River	Limited Man Warm Water Fishery	5,8,9,10,11

Group Analysis

Oxygen Related Constituents

There seems to be no significant change in BOD or DO; observations over the two time periods continue to show an average of 10 percent violations.

Bacteria

Bacterial violations remain at approximately 10 percent and are concentrated in the upper portion of the reach in the vicinity of Huron, South Dakota.

Nitrogen

Nitrogen violations show a significant increase over the two time periods. 38 percent to 59 percent. Here again the greatest concentrations occur immediately below the Huron station.

Phosphorus

Phosphorus violations continue at 100 percent throughout the length of this segment during each of the time periods.

TDS and Turbidity

Violations of TDS and turbidity criteria remain at near 80 percent.

Chloride and sulfate violations in the second time period are 19 percent and 62 percent respectively.

Other

No temperature violations were observed in the first time period. There was one violation in the second period at the South Dakota station north of Yankton. Three p^H violations were noted at Huron. Several manganese and mercury violations occurred.

Probable Cause

Two major sewage treatment plants are located at Mitchell and Huron. There are several industrial dischargers, upstream feedlots and irrigation diversions and returns on this reach.

Index Analysis

The index values (24-26) for this stream segment signify a slight decrease in quality. These calculations are probably more representative and reliable than others due to the relative abundance of data observed in this reach.

MISSOURI RIVER (CENTRAL)

SOUTH DAKOTA

Reach	Uses	State Classification
1. North Dakota Border to Big Bend Dam	Unlimited Man Cold Water Fishery	1,2,7,8,9,10,11
2. Big Bend Dam to the Iowa Border	Unlimited Man	1,4,7,8,9,10,11

Group Analysis

Oxygen Related Constituents

Over 6000 D.O. measurements with 20 violations were observed in the first trend period. No violations were found in the second period where some 1400 observations were made. One BOD violation occurred in period one, none were found in the second time period.

Bacteria (fecal and total)

No bacteria violations were found in either time period for that portion of the segment between the North Dakota border and the Pierre, South Dakota station. In the reach below Pierre and the Iowa border there were 16 percent violations noted in the first period and 20 percent violations in the second period all occurring at the station near Yankton, South Dakota.

Nitrogen

Nitrogen violations increased from 6 percent in period one to 25 percent in period two.

Phosphorus

Phosphorus violations went from 50 percent to 30 percent in the upper stream reach (above Pierre). No violations were observed in the lower stream reach during either period.

TDS and Turbidity

Measurements of TDS and turbidity violations remain much the same throughout the study periods and the supporting data are sparse for this segment. However, numerous conductivity measurements (1200) are available and show an overall violation percentage in excess of 20 percent. No sulfate violations occurred and only 3 chloride violations were observed.

Other

Two p^H violations appeared in the first period and seven (7) in the second; several mercury, lead, and cadmium (10) violations occurred in both periods.

Influencing Factors and Probable Causes

Quality is dominated by four major man-made lakes -- Oahe, Sharpe, Francis Case and Lewis and Clark. Irrigation diversions and returns on tributaries have some impact.

Two major sewage treatment plants are on the main stem and a major source of heavy metals tailings is located on a far upstream tributary.

Index Analysis

The index value increased from 2 to 6 over the two time periods and

reflects some deterioration. However, the overall quality for this segment of stream is generally quite good. Significant stations in the reach are below the Oahe, Big Bend and Gavins Point Dams.

BEAR RIVER

UTAH

Reach	Use	Classification
1. Headwaters to UT.-WY. state line	Limited Man Cold Water Fishery	CC
2. ID.-UT. state line to mouth	Limited Man Warm Water Fishery	CC

Group Analysis

Oxygen Related Index

The Geological Survey did not record any violations for the oxygen related group at their monitoring station near the Bird Refuge (mouth of the Bear River). However, 70 miles upstream the state reported that about 13 percent violations had occurred at their Amalga station.

Bacteria

The state recorded 56 and 67 percent bacteria violations at their Amalga station for the two time periods. Near the mouth of the Bear River the observed violations were 17 percent and 13 percent for the two respective time periods.

Nitrogen

The state recorded an increase in violations for the two time periods from 20 percent to 60 percent at their uppermost station; but a short distance downstream no violations were recorded. At the mouth the USGS recorded violations of 75 percent and 36 percent for the two time periods.

It appears that there is substantial irrigation throughout this reach and the upstream reach in Idaho which affects this pollutant group.

Phosphorus

Violations of the phosphorus pollutants varied between 42 percent and 80 percent. The violations computed for the total reach were 50 percent for the first time period and 65 percent for the latter period.

TDS

The percentage violations for this group for the two time periods were constantly 25 percent, except at the mouth where the USGS recorded 3 violations in 4 observations (75 percent).

Index Analysis

The index values for the reach of the Bear River between the Idaho-Utah state line and the mouth varied between 16 and 23. The differences in index values at each station for the two time periods were not significant for trend evaluation.

GREEN RIVER

UTAH

Reach	Use	Classification
1. Flaming Gorge Reservoir to UT.-CO. state line	Limited Man Cold Water Fishery	CC
2. CO.-UT. state line to mouth (Colorado River)	Limited Man Warm Water Fishery	CW

Group Analysis

Oxygen Related Group

The only violations observed were at the station near Jensen, Utah, where 4 percent was noted.

Bacteria

The State of Utah observed between 17 and 27 percent violations occurring in the reach between the Flaming Gorge Dam and Jensen, Utah. Also, 40 and 52 percent violations were noted above the wastewater treatment facility at Green River, Utah for the two respective time periods. No trends are discernible in the data for the lower reach of the Green River.

Nitrogen

Violations of 93 and 53 percent were recorded below the Flaming Gorge Dam for the two time periods. Perhaps the wastewater treatment plant located at Dutch John is responsible for these violations. Downstream 85 miles at Jensen, Utah, the State of Utah recorded 67 percent violations while the USGS recorded 18 percent. The next station, Green River, Utah, is located about 200 miles downstream. The violations here were 70 percent and 29 percent as determined by the state and USGS, respectively.

Phosphorus

Below the Flaming Gorge Dam the percentage of violations were about 15 percent. For the reach between Jensen and Green River, Utah, the percentage of violations were in the order of 60 percent. Trends cannot be determined because the variations of the index are not consistent between stations and for the two time periods. Differences in concentrations as determined by the USGS and the state could cause these wide variations in violations.

TDS

Violations of this parameter group begin with 2 percent observed near the headwaters in Wyoming and progressively rise to 40 percent at the Flaming Gorge Dam. At the Green River, Utah station the violations observed were about 80 percent. Values for both time periods were almost the same.

Index Analysis

The index for the Green River near the Flaming Gorge Dam was about 13 and at the Green River, Utah station it was about 20 for the second time period. Both these values represent a 25 percent increase over the values calculated for the first time period.

JORDAN RIVER

UTAH

Reach	Use	Classification
1. Utah Lake to Utah-Salt Lake County Line	Limited Man Cold Water Fishery	CW
2. Utah-Salt Lake County Line to mouth (Great Salt Lake)	Limited Man Cold Water Fishery	CC

Group Analysis

Oxygen Related Group

Violations were noted throughout the fifty mile length of the Jordan River in Utah. This reach is characterized by numerous municipalities and industries located alongside the front range of the Wasatch Mountains. Violations in excess of 80 percent were dominant at the water quality stations located below the discharge points of the wastewater treatment plants. The index values for both time periods were about the same thus, no trends could be determined.

Bacteria

Violations in the order of 15 percent were recorded below Utah Lake and the percentage levels rose to 80 percent below Murray, Utah and continued at that level throughout the remaining portion of the river. The State of Utah commonly monitors the stream above and below the discharge points of the numerous wastewater treatment plants. At most stations the data for the two time periods appear to be constant.

Nitrogen and Phosphorus

Percentage of violations for the entire length of the Jordan River is about 100 percent for each group.

TDS and Other

The Jordan River originates at the outlet of Utah Lake. At this point the TDS concentrations have been observed to be in the order of 1000 mg/l. At some of the downstream stations the concentrations are over 2000 mg/l. Also, the stream is highly concentrated with iron. At station No. 491545, the observed concentrations (µg/l) of some trace metals are as follows:

	Fe (diss.)	Fe (total)	Hg (total)	Mn (diss.)	Zn (diss.)
Violations	1	13	1	2	1
Observations	18	17	17	12	19
Minimum Conc.	0	200	0.0	0	0
Mean Conc.	43	1328	0.02	24	17
Maximum Conc.	700	7000	0.30	100	239

Index Analysis

Index values at the upper end of the Jordan River were 23 and 49 for the first and second time periods, respectively. These values progressively increase to the extent that they were 73 and 68 at the mouth near Farmington Bay.

WEBER RIVER

UTAH

Reach	Use	Classification
1. Headwaters to U.S. Highway 40	Limited Man Cold Water Fishery	CC
2. U.S. Highway 40 to mouth (Great Salt Lake)	Limited Man Warm Water Fishery	CW

Group Analysis

Oxygen Related Group

At the station above the Central Weber wastewater treatment facility the percentage of violations was 12 percent for the first period and 6 percent for the latter.

Bacteria

This parameter is directly related to the oxygen group. Surprisingly, the percentage of bacteria violations was found to be higher at the station above the plant. Yet, as would be expected the concentrations of total coliform were higher below the plant with a mean of 57,790 mpn/100 ml and a maximum over 100,000 mpn/100 ml.

Nitrogen

The stations for the three forks of the river, all located near the mouth, recorded 44 and 100 percent violations for this group. This parameter is NO_2+NO_3.

Phosphorus

Almost 100 percent violations of this parameter were recorded at each of the three fork's mouths of the Weber River. The USGS recorded 20 percent violations at their Gateway station which is located about 20 miles upstream from the mouth.

TDS

Percentage violations recorded above the Central Weber plant were 31 percent and 20 percent, respectively, for the two time periods.

Index Analysis

Only at one station was there sufficient data to calculate an index number. This station is located above the Central wastewater treatment facility. The calculated index was 22 for the first time period and 26 for the second period.

GREEN RIVER

WYOMING

Reach	Use	Classification
1. Headwaters to WY.-UT. state line	Cold and Warm Water Fishery	I

Group Analysis

Oxygen Related Group

No violations were observed.

Bacteria

The USGS recorded 17 percent and 74 percent violations at their stations above and below the City of Green River, Wyoming respectively. Probably, the high percentage violations at the latter station are due to the boom town effects of the extensive energy development activities occurring in the Bitter Creek drainage area. The recent influx of people into this area has overloaded the existing wastewater treatment facilities and has increased the bacterial concentrations of the groundwater in areas where there are no treatment facilities. The trend for the two time periods indicates a minor improvement and it is expected that substantial improvement will be evident in the future because of the Construction Grants Program.

Nitrogen

Although the Green River has been loaded severely by the wastewater treatment facilities at Green River and Rock Springs, there were only 4 percent nitrogen violations noted.

Phosphorus

Below the headwaters where the river leaves the mountain range, the percentage of violations for this group were 56 percent for the first time period and 10 percent for the second period. From this station to the station at Green River, Wyoming, the percentage of violations varied between 0 and 14 percent. At Green River, Wyoming, the percentage of violations were 78 percent.

TDS

Violations of this parameter group begins with 2 percent observed near the headwaters and progressively rise to 40 percent at the Flaming Gorge Dam.

Index Analysis

The segment of the Green River above the USGS Big Island station has an average index value less than 3. Just above the City of Green River, the value is about 8 and from a point below the City to the Flaming Gorge Dam the index is about 13. The indices for the two time periods are about the same.

NORTH PLATTE RIVER

WYOMING

Reach	Use	Classification
1. CO.-WY. state line to WY.-NB. state line	Cold and Warm Water Fishery	I

Group Analysis

Oxygen Related Index

Only one violation in 479 observations was noted.

Bacteria

The highest exceedances of criteria levels (75 percent) were recorded at the station below Casper, Wyoming. The percentage level drops to 29 percent at the next station downstream near Douglas. At the Wyoming-Nebraska state line the percentage level is 23 percent. The towns along the river are probably the main contributors along with some contributions coming from ranches.

Nitrogen

The frequency of nitrogen violations vary along the entire North Platte River. The violations are most apparent below the reservoirs where irrigation occurs. As would be expected from municipalities, there are increases of violations below the cities of Casper, Mills, Lingle, and Torrington.

Phosphorus

Violations of phosphorus are predominate throughout the Basin. The occurrence of violations approach 90 percent just downstream of the municipalities named in the Nitrogen index discussion.

TDS

The concentration of TDS builds up uniformly along the North Platte River and reaches a mean concentration of 660 mg/1 near the Wyoming-Nebraska state line. The maximum concentration recorded was 1010 mg/1 near Casper.

The State of Wyoming recorded TDS violations of 95 and 98 percent at their two stations of which one is located south of Douglas and the other is Rawhide Creek.

Other

The North Platte River Basin Valley must contain a substantial amount of iron. The concentration of dissolved iron in the river increases from 130 µg/1 near Seminoe Reservoir to about 270 µg/1 at Mills, Wyoming. The total iron concentrations vary from 240 µg/1 to 790 µg/1 at the two corresponding stations.

The index indicated a few violations of the trace metals between Alcova and the Wyoming-Nebraska state line. The proportion of violations (violations/observations) noted for this reach are as follows:

Cd, Total	- 7/7	Mn, Total	- 2/8
Cu, Dissolved	- 3/15	Pb, Total	- 7/7
Fe, Total	- 5/8	Zn, Dissolved	- 6/15
Hg, Total	- 3/8	Zn, Total	- 5/8
Mn, Dissolved	- 1/15		

Index Analysis

Above the station at Mills, Wyoming, the index was less than 5. Between Casper and the Wyoming-Nebraska state line the index fluctuated between 9 and 16 with the higher values appearing just below the larger municipalities. Trends are not discernible from the data because some segments show improvement while other segments show some degradation.

POWDER RIVER

WYOMING

Reach	Use	Classification
1. Headwaters to WY.-MT. state line	Cold and Warm Water Fishery	I

Group Analysis

Oxygen Related Index

There were four violations recorded in 24 observations at the Arvada station for the latter time period. This station is located some 70 miles below the next station upstream. Therefore, the extent of the dissolved oxygen problem is uncertain. The State of Wyoming 305(b) Report for 1976 mentions that the condition of oxygen depletion along this river is due to low flow velocity characteristics.

Bacteria Related Index

Violations of the bacteria index were detected at the first station at Kaycee and the violations are apparent all the way downstream. This problem is somewhat peculiar because there are only a few small towns located in the 200 miles of the main stem of the Powder River. But, there are a number of ranches in the upper portion of the basin and it is therefore surmised that the livestock is the contributing source.

The only large community in the Basin is the City of Buffalo which is located on Clear Creek, a tributary that enters the Powder

River below Arvada. Any effects noted for the City will be included in the Montana index.

The Wyoming 305(b) Report states that because of the condition of the City of Buffalo's wastewater treatment facilities, Clear Creek is in noncompliance with the state's water quality standards and is not expected to meet the 1983 goals.

Nitrogen

Nitrogen related violations for the entire river are in the order of 14 percent (7 violations in 50 observations.) The index identifies this parameter as dissolved nitrate nitrogen, NO_3-N. There is probably irrigation occurring along the upper reaches of the river for the hay fields but it is not known whether this is the contributing source of the nitrogen load.

Phosphorus

Violations for the phosphorus index average about 48 percent or 40 violations per 83 observations. Again, it is surmised that the excessive concentrations are derived from natural sources.

TDS

High percentage of violations for this category exists for the entire basin. The index reports maximum TDS concentrations of 2680 mg/1. Also, the state's 305(b) Report describes the problem very explicitly. A few condensed comments are:

> Soil erosion and natural runoff causes increases in sediment and salinity loads.

> Salinity loadings from numerous oil brine discharges into Salt Creek result in a fourfold concentration increase...
>
> The South Fork is classified as a high sediment loading area. Produced water from oil producing facilities contributes heavily to salinity.

This basin is characteristic of the deposits of sedimentary shales which are highly saline and erodible. Hence, any storm activity will cause the overland runoff to be highly concentrated with suspended solids. Also, the groundwater will be found to be highly concentrated with TDS.

Index Analysis

Index values for the stations near Kaycee, Wyoming were 8 and 12 for the respective two time periods. At the Arvada station (150 miles downstream) the index was 18 and 37. The higher index value for the second time period does not completely indicate a trend but does show the sensitivity of the index to the percentage of violations for the component groups. For example, it appears that for this basin the collection of 39 samples of phosphorus reveals a more significant number of violations (41 percent) than the 15 samples collected for the first time period (7 percent). Time of the year and frequency of data collection could be influencing factors.

WIND-BIG HORN RIVERS

WYOMING

Reach	Use	Classification
1. Headwaters to WY.-UT. state line	Cold and Warm Water Fishery	I

Group Analysis

Oxygen Related Group

For the total reach, only 3 violations were detected in 234 observations. The violations were below Boysen Dam.

Bacteria

Above Boysen Reservoir the exceedance of criteria levels was 53 percent, but no excesses were detected below the reservoir. According to the map, the source of these high values appears to be the wastewater treatment facilities owned by the City of Riverton, Wyoming. Further downstream from the reservoir, the percentage levels rise again to 50 percent near the cities of Lucerne and Worland and from there diminish to 29 percent near Kane. The small towns and ranches with livestock possibly account for these high bacteria levels.

Nitrogen

Nitrogen violations of 14 percent were recorded for the reach between Worland and Kane, Wyoming.

Phosphorus

Phosphorus violations (84 percent) were highest at the uppermost

stations of the Wind River. The minimum violations (11 percent) were noted at the station below Boysen Reservoir. Below this station to the Wyoming-Montana state line, the percentage of violations approached 57 percent.

TDS

This basin is characteristic of another typical salt producing area. TDS concentrations at the Dubois station range from 84 to 156 mg/1. At the Wyoming-Montana state line the TDS concentrations vary between 410 and 1010 mg/1. The percentage violations calculated for the entire river were 27 percent.

Other

The State of Wyoming 305(b) Report discusses the problem situation of the basin very adequately. Brief comments extracted from their report are as follows:

> Increases in coliform, salinity, and nitrogen are noted between Riverton and Boysen Reservoir.
>
> The segment below Riverton will not meet 1983 goals because of the nitrogen increases caused from the City's waste discharges and irrigation return flow. (Two other segments have been identified as not expected to meet '83 goals).
>
> Violations of Drinking Water Regulations for total gross Alpha and Beta occur below the Town of Thermopolis. This is caused by natural source.
>
> Produced water from oil extraction activities contributes heavily to salinity.

Index Analysis

The index values for the Wind River station at Riverton, Wyoming, were 4 and 7 for the two time periods. For the stations above Boysen Reservoir, the index was 12 and below the reservoir, which is the Big Horn River, the index was 3. The Big Horn River station at Kane, Wyoming, had an index value of 14 for both time periods.

SECTION II

AIR QUALITY REPORT

AIR QUALITY IN REGION VIII

I. Introduction

Monitoring of air quality in Region VIII has increased greatly in both scope and frequency over the last five years due to the public demand for information on harmful pollutants in the air and the passage of federal legislation in 1970 known as the Clean Air Act Amendments. Some minimal historical data are available prior to that time through such federal efforts as the National Air Sampling Network (NASN) and the Continuous Air Monitoring Program (CAMP), as well as state and local programs. However, with the State Implementation Plans required by the legislation, state agencies began aggressive monitoring plans which have resulted in the creation of an extensive monitoring networks and the building of a large air quality data base.

The majority of all data from these networks are stored in EPA's computerized system, Storage and Retrieval of Aerometric Data (SAROAD). In this data bank are stored measurements for a variety of atmospheric pollutants and meteorological measurements. The system is able to generate summary reports on the data it contains or it can print out the raw data in some suitable format. In Region VIII the Surveillance and Analysis Division is responsible for putting all the data into the system and responding to requests for summary information and raw data. The Division is also responsible for reporting on the quality of the Region VIII environment as measured by the air monitoring equipment at sites throughout the Region.

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This report summarizes available air quality data. It's primary objective is to determine the status and trends in air quality within the six-state Region. In achieving this objective, the report provides information on whether or not air quality standards have been achieved and defines areas which still have significant problems to solve. An attempt has been made to present the information in a form which can be understood by both technical and nontechnical readers and still accurately reflect actual conditions and complexities inherent in monitoring those conditions. Indices are used wherever possible.

The report is not intended to be a comprehensive analysis of cause and effect relationships or to evaluate the effects of control atrategies on air quality. However some general conclusions become evident from looking at the data. In addition, neither the collected data nor calculated indicators are beyond reproach. Data gaps, both in time and space, do exist and raise questions as to the appropriateness of certain indicators. Variations in weather which have tremendous impacts in examining trends over the years are not taken into consideration. The quality of the data itself may be questioned. The indicators have been developed to minimize these problems as much as possible, and the report narrative explains what the indicators may actually mean. Refinements to index calculation procedures, expanded networks, and better quality control in data collection and analysis should provide a better data base to work with in future reports.

The report contains two primary sections and Appendices. The first

section describes in general terms the monitoring activity in the Region and results of that monitoring. Indicators are defined and pollutants of primary interest are described in terms of their effects. The second section describes in greater detail the extent and magnitude of air quality problems throughout each state in the Region on a pollutant specific basis. Finally, future trends are predicted based on efforts to control pollution. The Appendices contain information on air quality standards and criteria used to calculate indicators for each pollutant.

II. Region-wide Summary

The Environmental Protection Agency has been given the authority to establish ambient air quality standards which specify, for the principal and most widespread classes of air pollutants, limitations necessary to protect the public health and welfare. These pollutants currently are total suspended particulate matter, sulfur dioxide, nitrogen dioxide, photochemical oxidants, and carbon monoxide. Standards for lead have recently been proposed.

Two types of standards were established. Primary standards are set at levels to protect human health. Secondary standards are set at levels to protect against other forms of damage to such things as vegetation and materials. The numerical value of each standard is listed in Appendix C.

Research has concluded that the following specific health effects can result from exposure to concentrations above the primary standards:

Total suspended particulates (TSP) -- aggravation of asthma and chronic lung diseases, increased cough, chest discomfort, restricted activity, aggravation of heart and lung disease symptoms in the elderly, increased death rates;

Sulfur dioxide (SO_2) -- aggravation of asthma, aggravation of heart and lung disease symptoms in the elderly, increased lung illness, increased death rate;

Carbon monoxide (CO) -- interference with mental and physical activity, reduced capacity in persons suffering from heart and other circulatory disorders;

Photochemical oxidants (O_x) -- aggravation of asthma and chronic lung disease, irritation of the eye and of the respiratory tract, decreased vision, reduced heart and lung capacity;

Oxides of nitrogen (NO_x) -- increased chronic bronchitis.

The severity of these effects increases with increased pollutant concentrations.

Status and trends in air quality are determined by comparing measurements made at monitoring stations to these standards. The main indicators used to characterize air quality in this manner is the number of days in which measurements exceeded the primary standards at the worst site in each county. The indicator may not represent air quality for the entire county, however the worst site is always selected in areas which have some population exposure so that the measured concentrations are affecting some segment of the population. To account for variations in meteorology the indicator is averaged over the three-year period, 1974-76.

A second indicator is used to demonstrate the severity of the problem. Each pollutant has been assigned an alert level, the concentration at which the public must be notified of possible adverse health effects. These values shown in Appendix D are significantly higher than the standards and are not frequently encountered. The average number of days per year (1974-76) over the alert level for each county has been chosen as the indicator of severity.

These two indicators correspond to breakpoints in the Pollutant Standards Index (PSI)[1] which is becoming the nationwide index for reporting air quality levels to the public. In the PSI the worst site pollutant concentration in each metropolitan area is chosen, and the index is calculated from the concentration at the site referenced to primary standards and alert levels. (see Appendix D)

Methods were developed to estimate the values of the indicators when samples are not always taken every day, instruments malfunction, and sites are moved. Otherwise there would be no standard procedure for comparing one site to another. These methods are detailed by pollutant in Appendix E.

The results of this analysis are summarized in Table 1 and shown graphically in Figure 1. A more detailed breakdown by state can be found in Section III.

Table 1
Summary of Air Monitoring in
Region VIII in 1976

	TSP	SO_2	NO_2	CO	Oxidants (ozone)[2]
Total sites	233	79	44	19	17
Counties with data	122	45	33	14	12
Counties exceeding primary standard	37	6	0	12	10
Counties exceeding alert level	14	5	0	7	1
Counties with deteriorating air quality	6	0	0	0	0
Counties with improving air quality	6	0	0	2	0
Counties with insufficient data or no discernible trend	110	45	33	12	12

Total number of counties: 291

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[1] U.S. EPA. "Guideline for Public Reporting of Daily Air Quality -- Pollutant Standards Index (PSI)," EPA 450/2-76-013, August 1976.

[2] Instrumentation measures ozone which is the primary constituent of oxidants.

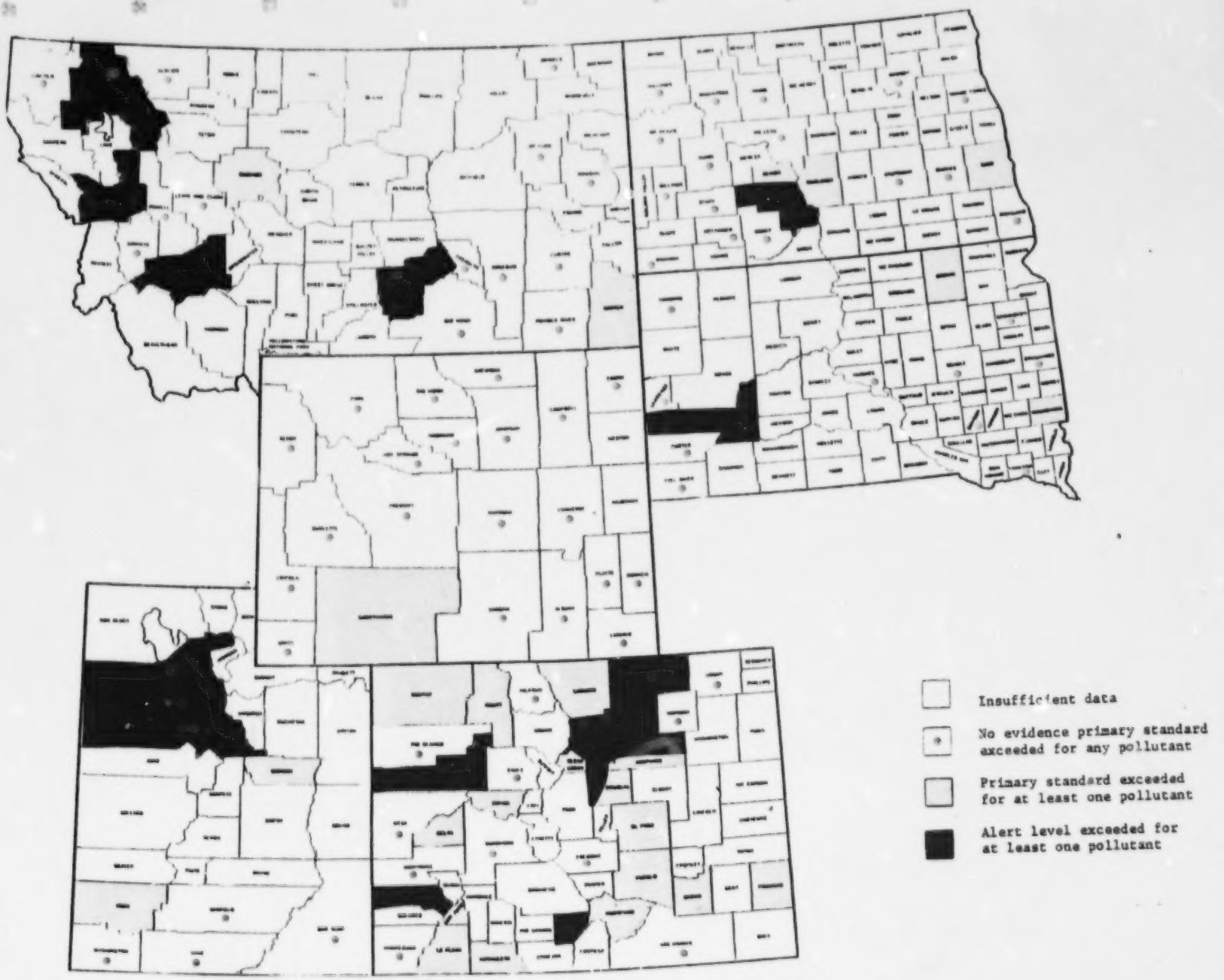

Insufficient data
No evidence primary standard exceeded for any pollutant
Primary standard exceeded for at least one pollutant
Alert level exceeded for at least one pollutant

Figure 1. Status of Air Quality by County.

It should be noted that if more than one pollutant is being monitored in the county, the map shows the worst of these pollutants; therefore for some counties the effects of multiple-pollutant problems are masked. County to county comparison cannot be made by relying on this map alone.

The extent of air quality monitoring shows total suspended particulate networks to be most prevalent followed in order by SO_2 and NO_2, respectively. Carbon monoxide and ozone are normally measured only in urban areas where the probability of encountering standards violations is high. NO_2 has proven to be a problem only in urban areas. Although violations have not occurred, to date, both Denver and Salt Lake County are on the threshold of exceeding the standard. More recent data indicate that Denver exceeded the NO_2 standard in 1977.

Status

TSP presents the most widespread pollutant problem with 37 counties over the primary standard. Only six counties are above the SO_2 standard and these are affected by specific point source of SO_2. Urbanized counties account for all 12 of those exceeding CO standards. Oxidant violations occur in 10 counties, both urban and non-urban, and there is a high probability that violations would be found in counties not now being monitored.

In terms of severity, only a few counties have values exceeding the alert level. Adams County north of Denver is singled out for reaching the oxidant alert level. Major urban counties have high CO

concentrations. Counties with or near point sources, smelters or refineries, have high SO_2 values. Explanations for high TSP values is more complex. Urban areas as well as high mountain valleys and smaller arid communities all have recorded values above the alert level.

Trends

As shown in Table 1, no significant, general, regionwide trends are evident except in the case of CO, which has been decreasing over the years in the central-city areas of both Salt Lake City and Denver. The number of counties showing decreasing concentrations of TSP equalled the number of counties with increasing TSP concentrations. Since the majority of sites in the Region have been established since 1972, an analysis of trends is somewhat impractical. Many of the counties described as having no trend actually had insufficient data to determine any accurate trend.

County-by-county trends are presented in the next section.

III. State Summaries

This section presents a summary of all air quality data in the Region, in terms of the five criteria pollutants. The indicators are 1) the average number of days per year over primary standard and 2) days over alert level.

A. Introduction to graphics

Figures 2 thru 7 show status and trends in air quality for all counties in which sufficient data are available. Trends are determined by criteria as described in Appendix E. Status is defined as an average over the three year period, 1974-76.

The frequency of occurrence of days over standard and alert level is shown in Figure 8 (a and b). It is possible to compare areas according to the severity and frequency of the problem by referring to the bar charts. The location of the worst site within the county is identified.

B. Inference and discussion by pollutant

TSP

TSP values which exceed alert levels are recorded in areas of widely differing degrees of topography, demography, and industrialization. Values exceeding standard in such places such as Pueblo, Colorado and Magna, Utah, may be explained, in part, by emissions from traditional sources. These are fuel combustion sources or industrial process emissions from both stacks and non-point fugitive emission sources.

FIGURE 2: STATUS AND TRENDS IN AIR QUALITY

COLORADO

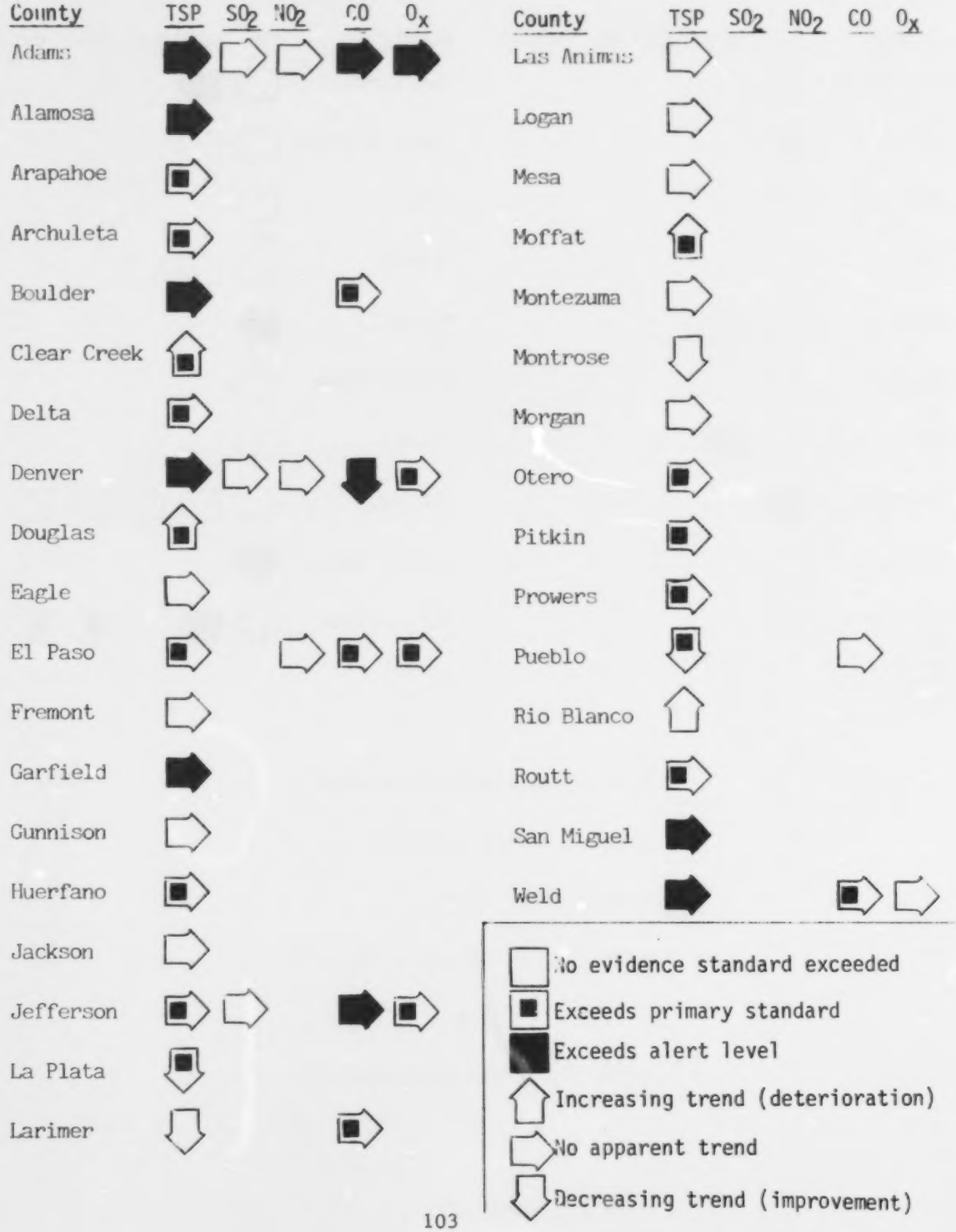
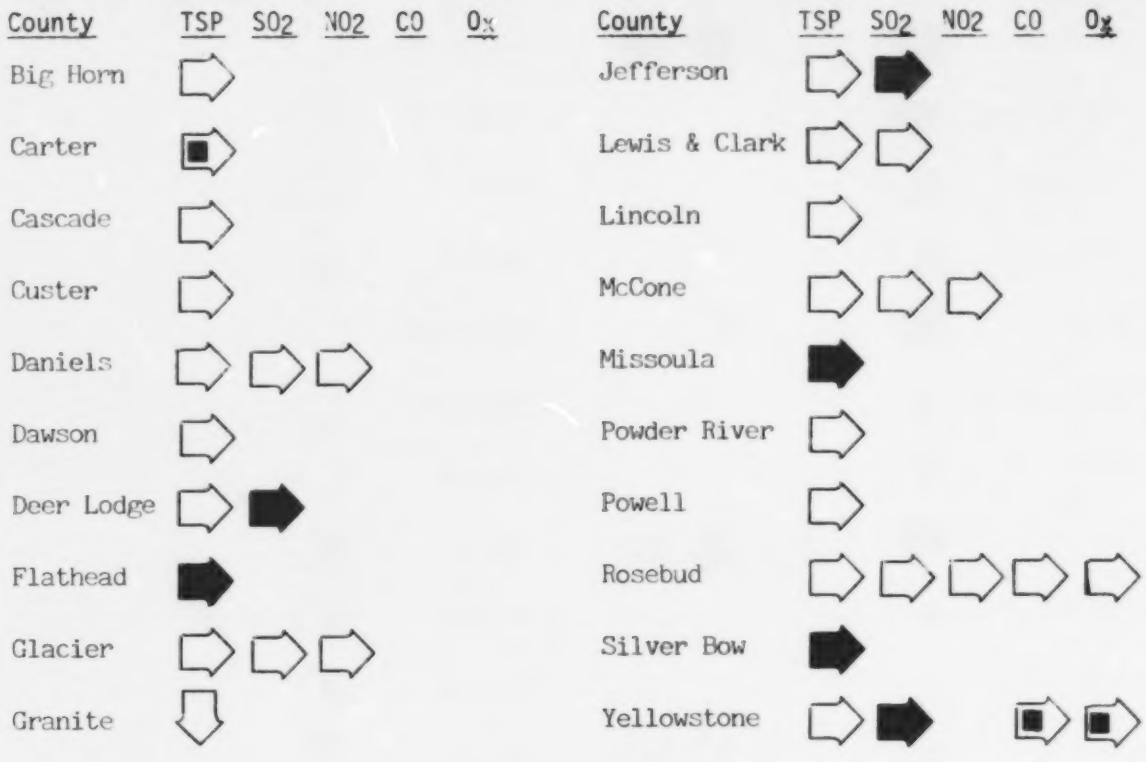


FIGURE 3: STATUS AND TRENDS IN AIR QUALITY

MONTANA



No evidence standard exceeded

Exceeds primary standard

Exceeds alert level

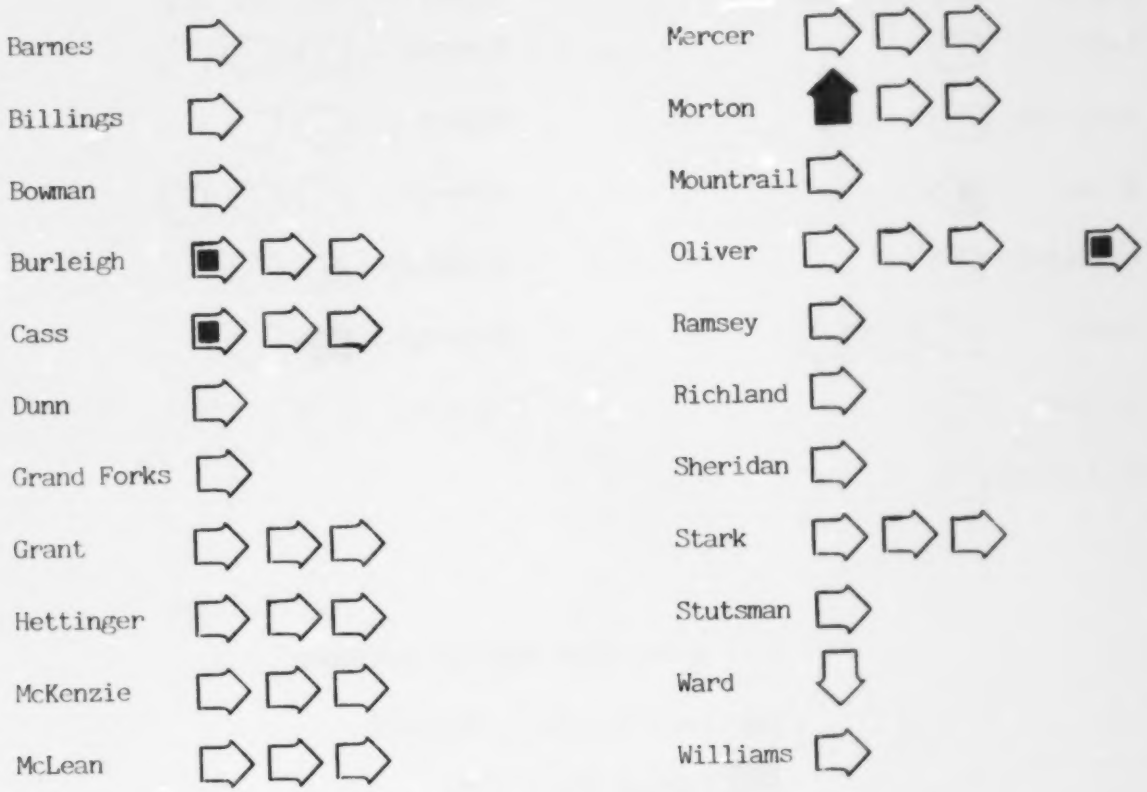
Increasing trend (deterioration)

No apparent trend

Decreasing trend (improvement)

FIGURE 4: STATUS AND TRENDS IN AIR QUALITY

NORTH DAKOTA



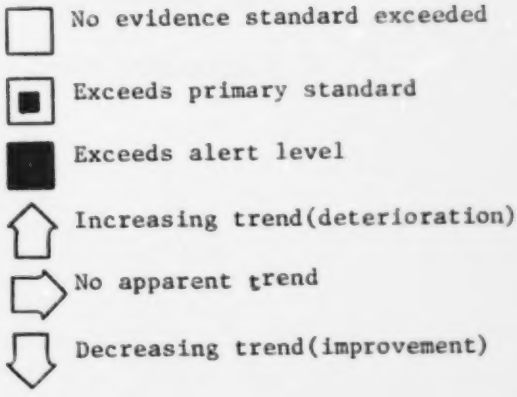
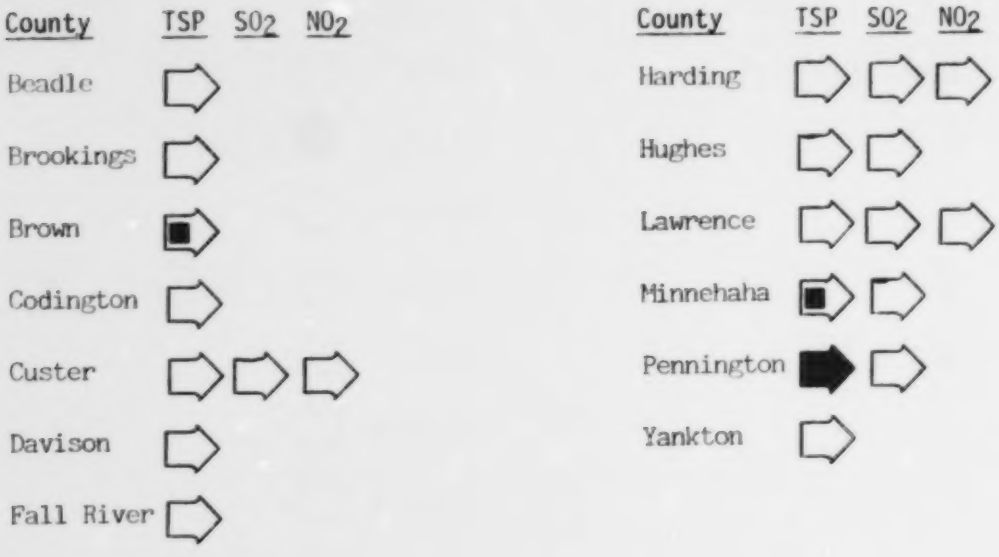


FIGURE 5: STATUS AND TRENDS IN AIR QUALITY

SOUTH DAKOTA



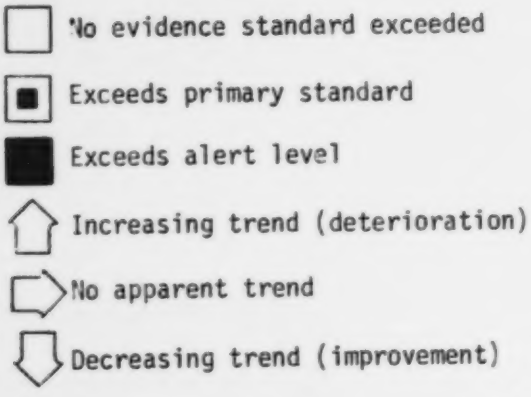
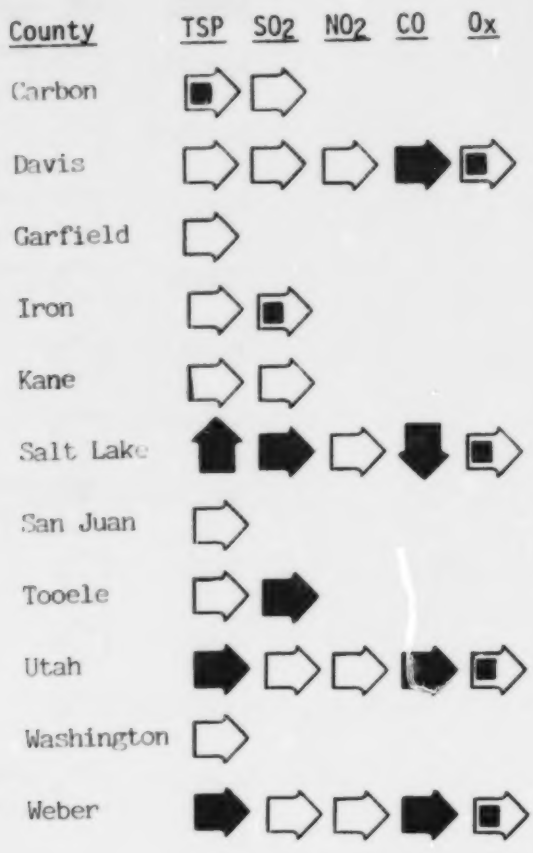


FIGURE 6: STATUS AND TRENDS IN AIR QUALITY

UTAH



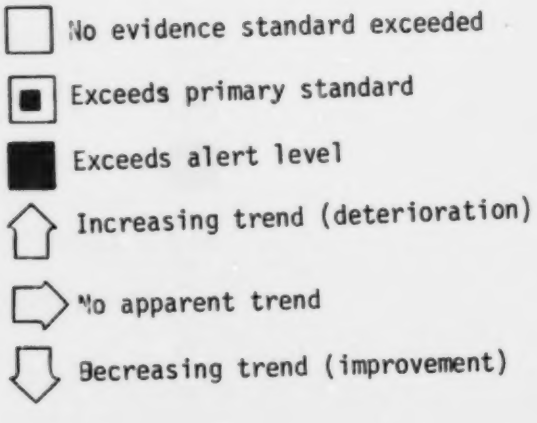
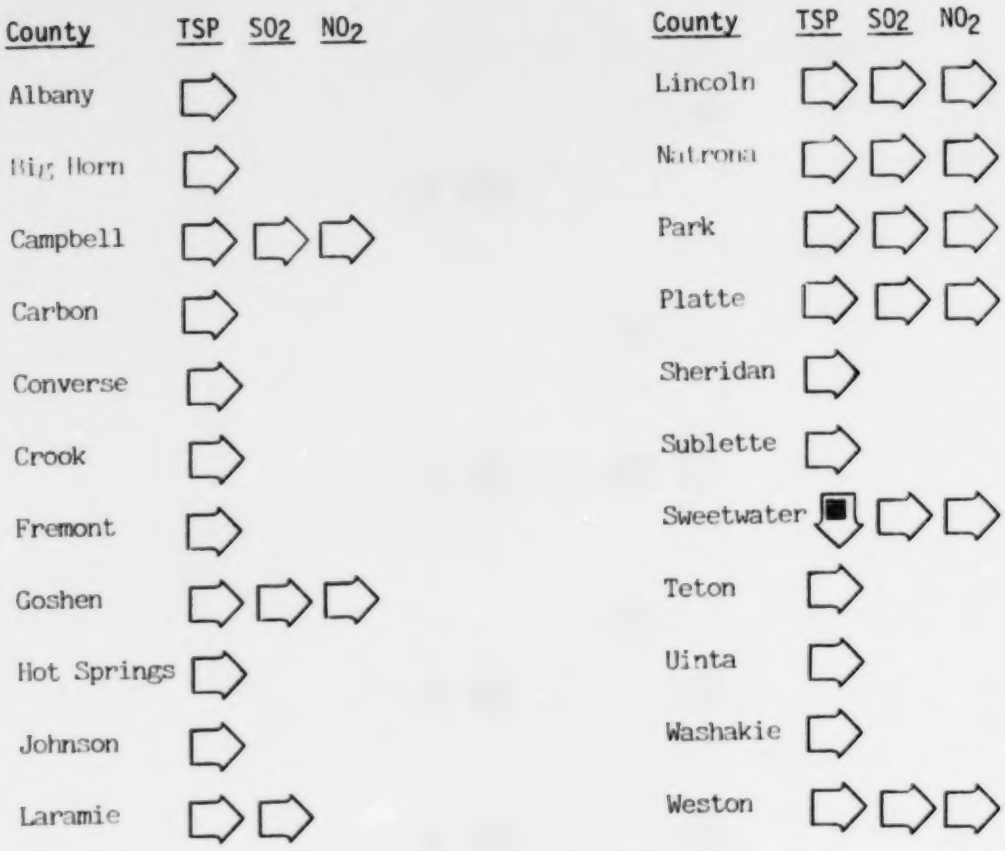


FIGURE 7: STATUS AND TRENDS IN AIR QUALITY

WYOMING



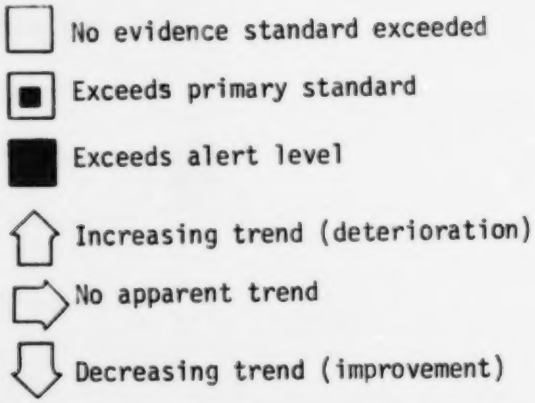


FIG. 8(a): NUMBER of DAYS OVER TSP PRIMARY STANDARD by SEVERITY

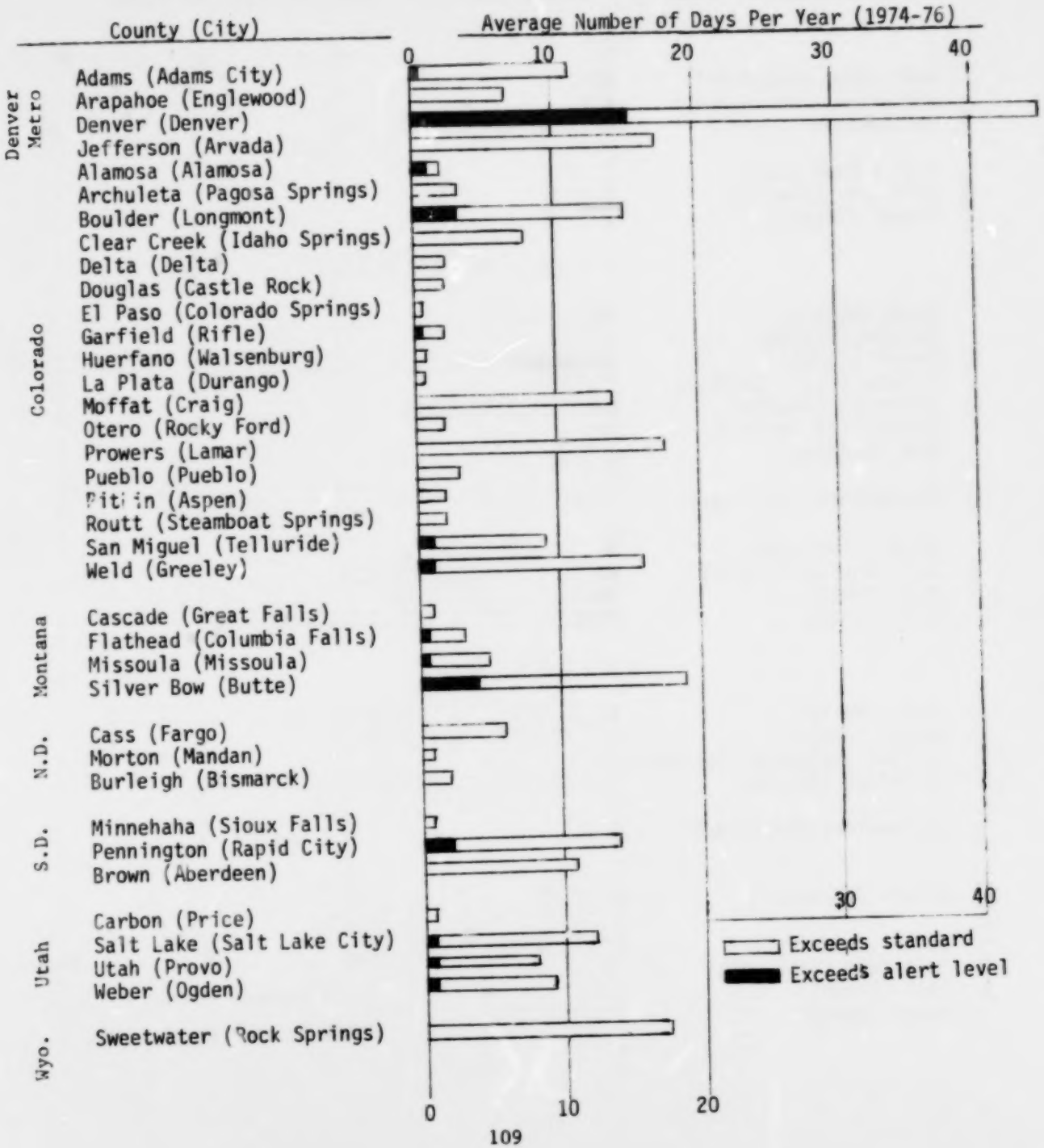
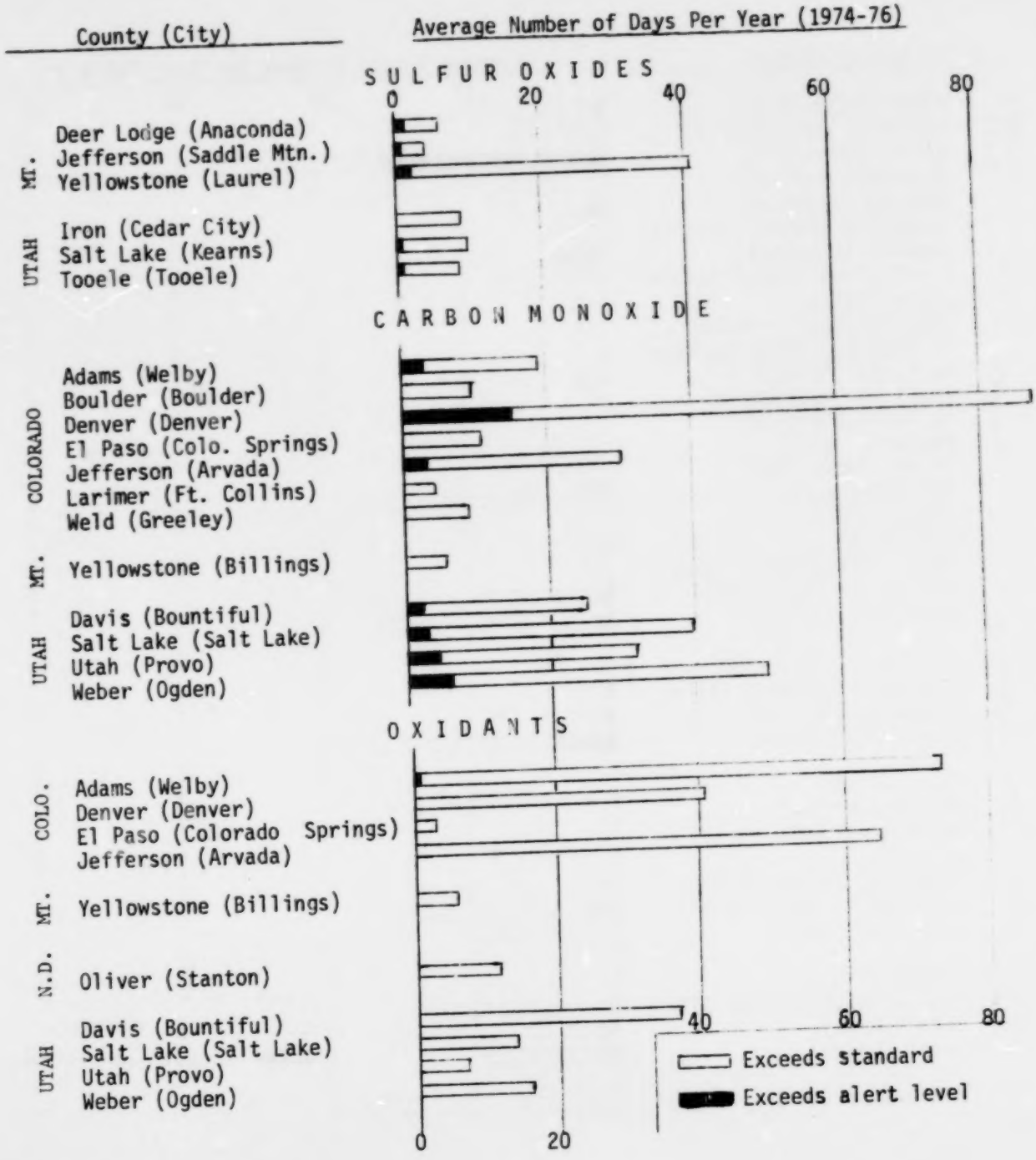


FIG 3(b): NUMBER of DAYS OVER STANDARD
by SEVERITY



Most of the airborne particulate in this Region emanate from nontraditional and natural sources. Nontraditional sources include dusty paved and unpaved roads, construction and demolition operation, auto exhaust, other urban activities (e.g., street-sanding), and agriculture. The semi-arid to arid climate which characterizes the area tends to exacerbate the potential for dust to become airborne. Windstorms are often severe enough to account for some high values. The combination of non-traditional sources and meteorology could provide one explanation for anomalies where alert levels are reached in communities like Telluride, Colorado, and Rapid City, South Dakota. General urban activity in cities of 30,000 or more seems sufficient to produce readings over the primary standard. No explanation is yet available for the high values at Aberdeen, South Dakota, and Columbia Falls, Montana.

In contrast to most of the country, TSP levels in this Region have not changed much over the years. No significant trend is evident anywhere, although some individual sites may display a trend in one direction or another. Since the indicators are based on 3 year averages, the figures do not show the effect of the drought on TSP levels, however, 1976 and 1977 values do appear somewhat higher than past years.

SO_2

Since SO_2 background concentration is negligible and the contribution from residential and commercial fuel combustion sources is minimal, the only sources of atmospheric SO_2 are fuel combustion

and industrial processes. Areas with high SO_2 levels usually coincide with the locations of smelters, refineries, and power plants.

NO_2

Both Denver and Salt Lake City are on the borderline of exceeding the annual NO_2 standard. (Recent data show the standard was exceeding in Denver in 1977.) The automobile is the major source. Monitoring for NO_2 by an acceptable method is relatively new, and no trends are discernible.

CO

The CO 8-hour standard is exceeded at nearly every location exposed to a sufficiently large average daily traffic load. In Denver, the CO standard is exceeded more frequently than any other standard, about 24 percent of the days each year, most frequently in the winter months. The levels in both downtown Salt Lake City and downtown Denver have been decreasing, however concentrations recorded at these sites are probably conservative estimators of actual levels since traffic is heavier at other locations. Insufficient historical data preclude analyzing for trends at any other sites.

Oxidants

Violation of the oxidant standard is probably more wide-spread and frequent than the data show. Although only 10 counties are shown as exceeding oxidant standards, the number is probably much higher, particularly in the Northern Great Plains, where data are not available. In many remote areas, even where the compounds which react to

form oxidants are not available in high concentrations, oxidant standards are exceeded. Whether the high values are natural or man-made is yet to be determined. Since oxidants are formed in the atmosphere and not emitted from sources, the highest concentrations are usually found downwind from major urban areas. Thus, Adams County north of Denver, Jefferson County west of Denver, and Davis County north of Salt Lake City are most frequently over standard. The site in Welby (Adams County) is over standard approximately 20 percent of the days of each year, mostly in the summer months.

IV. Outlook for the future

If trends in historical data are difficult to determine, predicting future ambient concentrations is little more than guesswork. On the other hand, if we can exclude variations in meteorology and look solely at emission rates and expected emission reductions due to control programs, the picture becomes somewhat clearer. Some general predictions can be made.

The outlook for SO_2 is probably the best since point sources can be controlled through the addition of control equipment for existing sources and reviews of new sources for appropriate emission limitations. SO_2 concentrations should thus be decreasing in areas which are now recording values over the standard. Slight increases may occur in areas surrounding new power plants or other energy related developments, as the prevention of significant deterioration increments are used up.

The outlook for TSP is not as encouraging due to the nature of TSP sources in the Region and the dry climate. Some decrease may occur in central-city areas due to control strategies aimed at non-traditional sources, however not much improvement is expected from natural sources of windblown dust in rural areas. An extended drought would increase values substantially.

Pollutants from the automobile will continue to be a problem over the next few years until the combined effects of emission controls on cars and inspection-maintenance programs begin to reduce emissions, or

until significant reductions are made in vehicle-miles-traveled in urban areas. A recent study* predicts a gradual reduction in both CO and oxidants, over the next 20 years, despite an increase in the number of registered vehicles, because of the Federal Vehicle Emission Control Program. Localized CO problems will continue to exist in locations of high vehicular traffic. NO_2 concentrations, may increase and perhaps begin to exceed annual standards in urban areas because strict emission control standards for cars have been delayed and production of NO_2 in the photochemical smog reactions as hydrocarbon levels are lowered. This study was completed prior to the Clean Air Act Amendments of 1977, which postponed the requirements for high altitude certification of new cars at least until 1981. In addition recent information on high altitude emissions indicate even higher emission rates than originally used in the study.

Enough data should be available for subsequent reports to allow a better analysis of trends in oxidants and NO_2. Procedures will also be available to adjust data for meteorological conditions. Trends in population exposure to various pollutants will be a feature of future reports.

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* "Air Quality in Denver Metropolitan Region, 1974-2000," EPA Region VIII, EPA-908/1-77-002 (May, 1977).

APPENDICES

Water

A. State Water Quality Standards Utilized in Water Quality Index Program

B. State Water Quality Standards

Air

C. National Ambient Air Quality Standards

D. Breakpoints for Pollutant Standards Index

E. Procedures Used to Construct Indices and Judge Trends

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APPENDIX A

State Water Quality Standards and/or Criteria
Utilized in Water Quality Index Program

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STATE WATER QUALITY STANDARDS

(Utilized in Water Quality Index Program)

	Reach Class	DO	BOD	Total Coliform	Fecal Coliform	Chloride	Sulfate
	Colorado						
1.	B1	6.0	10	1000	1000	250	250
2.	B2	5.0	10	1000	1000	250	250
	Montana						
3.	B, D1	7.0	10	1000	200	250	250
4.	B, D2	7.0	10	100	200	250	250
5.	B, D3	5.0	10	1000	200	250	250
6.	C, D1	7.0	10	1000	200	250	250
7.	C, D2	7.0	10	1000	200	250	250
	North Dakota						
8.	I	5.0	10	1000	200	100	250
9.	IA	5.0	10	1000	200	175	450
	South Dakota						
10.	A	5.0	10	5000	1000	100	250
11.	B	5.0	10	1000	200	100	250
12.	C	5.0	10	1000	200	100	250
13.	D	5.0	10	1000	200	100	250
14.	E	5.0	10	5000	1000	100	250
	Wyoming						
15.		6.0	10		1000*	250	250
	Utah						
16.	C	5.5	5	5000		250	250
17.	CC	6.0	5	5000		250	250
18.	CW	6.0	5	5000		250	250

*Seasonal

Criteria Utilized in Water Quality Index Program

STORET Number	Parameter	Standard Value	
Nutrient Group			
	Nitrogen		
00631	NO_2 & NO_3	0.6	mg/l
00618	NO_3-N	0.6	"
71851	Nitrate	2.6	"
00630	NO_2 & NO_3	0.6	"
00620	NO_3-N	0.6	"
71867	Total N	2.6	"
00600	Total N	0.6	"
	Phosphorus		
00665	Phos.-Tot.	0.03	"
00650	T. PO_4	0.09	"
00666	Phos.-Dis.	0.03	"
00660	Ortho PO_4	0.09	"
00671	Phos.-Dis.	0.03	"
TDS			
00095	Conductivity	750	µMHO
00515	Residue	500	mg/l
70295	Residue	500	"
70300	Residue	500	"
Trace Metals and Others			
01005	Barium-Dis.	1000	µg/l
01025	Cadmium-Dis.	4	"
01027	Cadmium-Tot.	4	"
01030	Chromium-Dis.	50	"
01034	Chromium-Tot.	50	"
01040	Copper-Dis.	20	"
01042	Copper-Tot.	20	"
00950	Fluoride-Dis.	1.6	"
00951	Fluoride-Tot.	1.6	"
01046	Iron-Dis.	300	"
01045	Iron-Tot.	300	"
71890	Mercury-Dis.	0.2	"
71900	Mercury-Tot.	0.2	"
01056	Manganese-Dis.	50	"
01055	Manganese-Tot.	50	"
01065	Nickel-Dis.	100	"
01067	Nickel-Tot.	100	"
01049	Lead-Dis.	30	"
01051	Lead-Tot.	30	"
09503	RA-226	3	pC/l
01147	Selenium-Tot.	10	µg/l
01090	Zinc-Dis.	30	"
01092	Zinc-Tot.	30	"

APPENDIX B

State Water Quality Standards

COLORADO
WATER QUALITY STANDARDS SUMMARY

STANDARD	CLASS			
	A_1	A_2	B_1	B_2
Settleable Solids	Free From	Free From	Free From	Free From
Floating Solids	Free From	Free From	Free From	Free From
Taste, Odor, Color	Free From	Free From	Free From	Free From
Toxic Materials	Free From	Free From	Free From	Free From
Oil and Grease	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration
Radioactive Material	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards
Fecal Coliform Bacteria Geometric Mean	<200/100ml	<200/100ml	<1000/100ml	<1000/100ml
Turbidity	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.
Dissolved Oxygen	6 mg/l minimum	5 mg/l minimum	6 mg/l minimum	5 mg/l minimum
pH	6.5 - 8.5	6.5 - 8.5	6.0 - 9.0	6.0 - 9.0
Temperature	Maximum 68°F. Maximum Change 2°F.	Maximum 90°F. Maximum Change: Streams - 5°F. Lakes - 3°F.	Maximum 68°F. Maximum Change 2°F.	Maximum 90°F. Maximum Change: Streams - 5°F. Lakes - 3°F.

(1) Special limits for the Clark Fork have been established.

Montana

Water Quality Standards Summary

	A-Closed	A-Open-D_1	B-D_1	B-D_2	B-D_3	C-D_1	C-D_2	E-F
Total Coliform (Average)	50/100 ml max. Total coliform	50/100 ml max. Total coliform	200/100 ml fecal 1000/100 ml Total coliform	200/100 ml fecal 1000/100 ml Total coliform	200/100 ml fecal 1000/100 ml Total coliform	200/100 ml fecal 1000/100 ml Total coliform	200/100 ml fecal 1000/100 ml Total coliform	200/100 ml 1000/100 m Total coli
Dissolved Oxygen	NA	7.0 mg/l Minimum	7.0 mg/l Minimum	7.0 mg/l Oct. 1 - June 1 6.0 ml/l June 2 - Sept 30	5.0 mg/l Minimum	7.0 mg/l Minimum	7.0 mg/l Oct. 1 - June 1 6.0 ml/l June 2 - Sept 30	3.0 mg/l Minimum
pH	No change	6.5 - 8.5	6.5 - 8.5	6.3 - 9.0	6.5 - 9.0	6.5 - 8.5	6.5 - 9.0	6.5 - 9.5
Turbidity	No Increase	No increase	No more than 5 JTU increase	No more than 10 JTU increase	No more than 10 JTU increase	No more than 5 JTU increase	No more than 10 JTU increase	Not to incr in quantity amts which <Adversely affect the indicated
Temperature	No increase	Max. 67°F Max. change 1°F	Max. 67°F Max. change 1°F	Max. 67°F Max. change 1°F	Max. 77°F Max. change 3°F	Max. 66°F Max. change 1°F	Max. 67°F Max. change 1°F	Same as above
Settleable Solids	No increase	No increase	No increase	No increase	No increase	No increase	No increase	<Adversely affect the use indic
Sedimentation Res.	No increase	No increase	No increase	No increase	No increase	No increase	No increase	Same as above
Radioactive Material	No waste	I 131 5 pc/l R_a226 1 pc/l S-89 100 pc/l S-90 10 pc/l Tritium 3000 pc/l	See A-Open	See A-Open	See A-Open	See A-Open	See A-Open	See A-Open
Toxic Materials (Free From)	No increase	Drinking Water Standards	Drinking Water	Drinking Water	Drinking Water	Not to exceed levels known to be of public health significance	Not to exceed levels known to be of public health significance	<Adversely affect the use indic
Oil & Grease	No increase	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exc 10 mg/l
Color	NA	No increase of more than 5 units	No increase of more than 5 units	No increase of more than 5 units	No increase of more than 5 units	No increase of more than 5 units	No increase of more than 5 units	Same as above

North Dakota

Water Quality Standards Summary

	Class I	Class IA	Class II	Class III
Fecal Coliform Geometric Mean	200/100 ml.	200/100 ml.	200/100 ml.	1000/100 ml.
Total Coliform Geometric Mean	1000/100 ml.	1000/100 ml.	1000/100 ml.	1000/100 ml.
Dissolved Oxygen	5.0 mg/l minimum	5.0 mg/l minimum	5.0 mg/l minimum	5.0 mg/l minimum
pH	7 - 8.5	7 - 8.5	6 - 9	6 - 9
Turbidity (1)	10 JU	10 JU	25 JU	40 JU
Temperature	85°F maximum 5°F max. change	85°F maximum 5°F max. change	90°F maximum 3°F max. change	90°F maximum 3°F max. change
Color	15 units	15 units	25 units	40 units
Taste, odor	Free from	Free from	Free from	Free from
Floating Solids	Free from	Free from	Free from	Free from
Toxic Material	Free from	Free from	Free from	Free from
Oil & Grease	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l	Not to exceed 10 mg/l
Iodine 131	5 pc /l	5 pc/l	5 pc/l	5 pc/l
Radium-226	1 pc /l	1 pc/l	1 pc/l	1 pc/l
Strontium-89	100 pc /l	100 pc/l	100 pc/l	100 pc/l
Strontium-90	10 pc /l	10 pc/l	10 pc/l	10 pc/l
Tritium	3000 pc /l	3000 pc/l	3000 pc/l	3000 pc/l

(1) Unless due to runoff

North Dakota
Water Quality Standards Summary

	Class I	Class IA	Class II	Class III
Ammonia	1.0 mg/l	1.5 mg/l	1.5 mg/l	2.0 mg/l
Arsenic	0.05 mg/l	0.05 mg/l	0.0 mg/l	0.1 mg/l
Barium	1.0 mg/l	1.0 mg/l	1.0 mg/l	1.0 mg/l
Baron	0.5 mg/l	0.5 mg/l	0.5 mg/l	0.75 mg/l
Cadmium	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.01 mg/l
Chlorides	100 mg/l	175 mg/l	250 mg/l	250 mg/l
Chromium (hexa) or trivalent	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.05 mg/l
Copper	0.05 mg/l	0.05 mg/l	0.1 mg/l	0.1 mg/l
Cyanides	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.1 mg/l
Lead	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.1 mg/l
Nitrates	4.0 mg/l	4.0 mg/l	5.0 mg/l	5.0 mg/l
Phenols	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.01 mg/l
Phosphates (as "P")	0.1 mg/l	0.1 mg/l	0.2 mg/l	0.2 mg/l
Selenium	.01 mg/l	.01 mg/l	.01 mg/l	.01 mg/l
TDS (2)	500 mg/l	1000 mg/l	1000 mg/l	>1000 mg/l
Zinc	0.5 mg/l	0.5 mg/l	1.0 mg/l	1.0 mg/l
Sodium % of cations	50%	60%	60%	60%

(2) Unless naturally higher

South Dakota
Water Quality Standards Summary

	1	2	3	4	5	6	7	8	9	10(5-1/9-30)	11
TDS	1000 mg/l	1000 mg/l	1000 mg/l	1000 mg/l	1000 mg/l	1000 mg/l	1000/100 ml	1000 mg/l	2500 mg/l	1500 mg/l	2000/mg/l
Nitrates (as N)	10 mg/l	10 mg/l	10 mg/l	10 mg/l	10 mg/l	10 mg/l	10 mg/l	10 mg/l	50 mg/l HNO_3	50 mg/l as NO_3	50 mg/l as NO_3
pH	6.0-9.0	6.6-8.6	6.5-8.8	6.5-9.0	6.3-9.0	6.0-9.0	6.5-8.3	6.0-9.0	6.0-9.5	6.0-9.5	6.0-9.5
Total coli. Geometric Mean	5000/ 100 ml	5000/ 100 ml	5000/ 100 ml	5000/ 100 ml	5000/ 100 ml	5000/ 100 ml	1000/100 ml Recreation season any sample 2000/ 100 ml	5000/100 ml Recreation season any sample 10,000/100 ml	See #8	5000/ 100 ml root crops/ rec. area	5000/ 100 ml
Fecal coli. Geometric Mean	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	200/100 ml recreation season any sample 400/ 100 ml	1000/100 ml recreation season any sample 2000/ 100 ml	See #8	1000/ 100 ml root crops/ rec. area	1000/ 100 ml
Chlorine Res	Free from	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l
Ammonia Nitrogen (as N)	Free from	0.06 mg/l	1.0 mg/l	1.0 mg/l	1.0 mg/l	1.5 mg/l	1.5 mg/l	1.5 mg/l	1.5 mg/l	1.5 mg/l	1.5 mg/l
Chlorides	Free from	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l	100.0 mg/l
T. Cyanide	Free from	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l	0.02 mg/l
Free Cyanide	Free from	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l	0.005 mg/l
D.O.	Drinking Water Standards	6.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l	5.0 mg/l
D.O. Spawning Season	N/A	7.0 mg/l	7.0 mg/l	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

South Dakota (Contd)
Water Quality Standards Summary

	1	2	3	4	5	6	7	8	9	10	11
H_2S (undissociated)	Free from	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l	0.002 mg/l
T. Iron	Free from	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l	0.2 mg/l
TSS	Free from	30 mg/l	90 mg/l	90 mg/l	90 mg/l	150 mg/l	150 mg/l	150 mg/l	150 mg/l	150 mg/l	150 mg/l
Temp.	Drinking Water Standards	65°F max.	75°F max.	80°F max.	90°F max.	90°F max.	90°F max.	90°F max.	90°F max.	90°F max.	90°F max.
Turbidity	Drinking Water Standards	10 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.	50 J.C.U.
Conductivity									4000 micro MHO's at 25°C	2500 micro MHO's at 25°C	2500 micro MHO's at 25°C
Sodium abs. ratio										10	
Alkalinity (as C_aCO_3)									750 mg/l		

NOTES - SOUTH DAKOTA

For All Classifications

A. Radioactive Material

Iodine	- 131 -	5	pc/l
Radium	- 226 -	1	pc/l
Strontium	- 89 -	100	pc/l
Strontium	- 90 -	10	pc/l
Tritium	-	300	pc/l

B. Toxic Materials Above Standard

Allowed for certain beneficial purposes if no danger to health

C. Petroleum Products

No materials of petroleum derivation shall be discharged which results in concentration of excess of 10 mg/l or imparts of visible film or sheen

D. Gas Pressure

Less than 110% of saturation.

Utah
Water Quality Standards Summary

	"A"	"B"	"C"	"CC"	"CW"	"CR"	"CCR"	"CWR"	"D"	"E"	"S"
Total coliform Average	Drinking Water Standards	50/100 ml	5000/100 ml	See C	See C	1000/100 ml	See C	See C	5000/100 ml	There shall be no discharge of any waste into Class "E" waters	Same as Class "A" except for specific waste discharges permitted by Committee and Board
Fecal coliform	Drinking Water Standards	See A	See A Except Biological Water Std's	See C	See C	See C	See C	See C	See C		
B.O.D.	Free from	See A	5 mg/l	See C	See C	See C	See C	See C	25 mg/l		
D.O.	Drinking Water Standards	See A	5.5 mg/l	6.0 mg/l	See C	See C	See C	See C	See A		
pH.	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	See C	See C	See C	See C	6.5-9.0		
Temp.	Suitable for intended use	See A	See A	68°F max 2°F change	80°F max 4°F change	See A	68°F max 2°F change	80°F max 4°F change	None Added		
Chemical Standards	Drinking Water Standards	See A	See A	See A	See A	See A	See A	See A	See A		
Physical Standards	Drinking Water Standards	See A	See A	See A	See A	See A	See A	See A	See A		
Radiological Standards	1/30th of MPCW Values	See A	See A	See A	See A	See A	See A	See A	See A		
Settleable Solids	Free from	See A	See A	See A	See A	See A	See A	See A	See A		
Floating Solids	Free from	See A	See A	See A	See A	See A	See A	See A	See A		

Wyoming
Water Quality Standard Summary

	I	II	III
Fecal Coliform Geometric Mean	*May 1 thru Sept. 30 200/100 ml primary contact 1000/100 ml secondary contact	**May 1 thru Sept. 30 1000#/1 secondary contact	None
Total Coliform	None	None	None
D.O.	6.0 mg/l	5.0 mg/l	None
Floating Solids	Free from	Free from	Free from
Oil & Grease	10 mg/l max.	10 mg/l	10 mg/l
pH	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
Radioactive Material	BPT	BPT	BPT
a. Radium - 226	3 pc/l		
b. Strontium - 90	10 pc/l		
Salinity	--	--	Under study
Settleable Solids	Free from	Free from	Free from
Taste, Odor, and Color	Free from	Free from	None
Temperature	Warm water 90°F (max) Cold water 78°F (max.) 2°/4° max. increase	Warm water 90°F (max.) Cold water 78°F (max.) 2°/4° max. increase	None
Toxic Material	Free from	Free from	Free from
Turbidity	Increase of 10 JTU max.	Increase of 10 JTU max.	None
Total Gas Pressure	110% of Atmosphere	110% of Atmosphere	110% of Atmosphere

* Applies to still water below 7000 feet and certain other streams.
** Applies to all other waters not in I.

APPENDIX C

National Ambient Air Quality Standards

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time period/standard	Maximum permissible concentration
Suspended particulate matter (Total suspended particulates) (TSP)	Annual, secondary	60 $\mu g/m^3$
	Annual, primary[a]	75 $\mu g/m^3$
	24-hr, secondary[b]	150 $\mu g/m^3$[c]
	24-hr, primary	260 $\mu g/m^3$[c]
Sulfur dioxide (SO_2)	Annual, primary	80 $\mu g/m^3$
	24-hr, primary	365 $\mu g/m^3$[c]
	3-hr, secondary	1300 $\mu g/m^3$[c]
Carbon monoxide (CO)	1-hr, primary	40 mg/m^3
	8-hr, primary	10 mg/m^3
Oxidants/ozone (O_x + Oz or O_3)	1-hr, primary	160 $\mu g/m^3$[c]
Nitrogen dioxide (NO_2)	Annual, primary	100 $\mu g/m^3$[c]

[a]Primary: to protect public health.

[b]Secondary: to protect public welfare.

[c]These values are not to be exceeded more than once per year.

APPENDIX D

Breakpoints for Pollutant

Standards Index

(Includes alert level for each pollutant)

Breakpoints for PSI (ψ) in Metric Units

Breakpoints	PSI Value (ψ)	TSP $\mu g/m^3$ 24-hr.	SO_2 $\mu g/m^3$ 24-hr.	TSP x SO_2 $(\mu g/m^3)^2$	CO mg/m^3 8 hours	O_3 $\mu g/m^3$ 1-hr.	NO_2 $\mu g/m^3$ 1-hr.
50% of primary short-term NAAQS	50	75[a]	80[a]	b	5.0	80	b
Primary short-term NAAQS	100	260	365	b	10.0	160	b
Alert Level	200	375	800	65×10^3	17.0	400[c]	1130
Warning Level	300	625	1600	261×10^3	34.0	800	2260
Emergency Level	400	875	2100	393×10^3	46.0	1000	3000
Significant Harm Level	500	1000	2620	490×10^3	57.5	1200	3750

[a]Annual primary NAAQS.

[b]No index value reported at concentration levels below those specified by the Alert level criteria.

[c]For the PSI index 400 $\mu g/m^3$ appears to be a more consistent breakpoint between the descriptor words "unhealthful" and "very unhealthful" than the O_3 Alert Level of 200 $\mu g/m^3$.

APPENDIX E

Procedures Used to Construct Indices and Judge Trends

TOTAL SUSPENDED PARTICULATE

Indices

1. Select worst site in each county based on
   - o Number of days per year greater than 260 $\mu g/m^3$ averaged over three year period (1974-76)
   - o Data available in 1976
   - o Population exposure of site. Should be representative of populated area of county

2. For the selected site, estimate the number of days greater than 260 $\mu g/m^3$ for each year (1974-76) and average over the years of record.
   - o In years with no recorded violations, estimate is automatically zero
   - o For other years estimate is made assuming a log-normal distribution of data throughout the year
   - o If data are not log-normal, actual distribution is used to estimate number
   - o If data do not allow for construction of a credible distribution, the actual number of days over standard is used

3. For same site, estimate number of days with at least one average greater than 375 $\mu g/m^3$.
   - o Use same criteria as above

Trend

1. Analysis done only for counties with 5 or more years of data.
2. Judgements based on
   - o Annual frequency distributions
   - o Annual geometric means
   - o Number of days per year greater than primary standard
   - o Second highest values per year
   - o Trends in other sites within county

SULFUR DIOXIDE

Indices

1. Select worst site in each county based on
   - o Population exposure. Must be in area where people are present
   - o Representativeness within county
   - o Number of days per year greater than 24-hour average of 365 $\mu g/m^3$
   - o Data available in 1976

2. For the selected site, average number of days per year greater than primary 24-hour standard for three year period (1974-76).
   - o Actual data used
   - o Continuous data preferred over non-continuous

3. For same site count number of days with at least one average greater than 800 $\mu g/m^3$.
   - o Actual data used

Trends

1. Analysis done only for counties with 5 or more years of data.
2. Judgements based on
   - o Number of days per year over standard
   - o Annual frequency distribution
   - o Second highest value per year
   - o Annual average

NITROGEN DIOXIDE

Indices

1. Select worst site in each county based on
   - o Highest annual average
   - o Data available in 1976
2. Determine whether annual average is greater than 100 $\mu g/m^3$, average 1974-76.
   - o Actual data are used
   - o Years without valid annual average are disregarded

Trends

1. Analysis done only for counties with 5 or more years of data.
2. Judgements based on
   - o Annual average concentrations
   - o Annual frequency distributions
   - o Trends in other sites within county

CARBON MONOXIDE

Indices

1. Select worst site in each county based on
   - o Number of days greater than 10 mg/m^3 8-hour average
   - o Data available for 1976

2. For selected site, count the number of days per year (1974-76) with at least one 8-hour average greater than 10 mg/m^3. Average these yearly values.
   - o For periods with no data, estimate by examining data for same site for same period of other years and by looking at data for other nearby sites.

3. For same site count number of days with at least one average greater than 17 mg/m^3.
   - o Actual number always used

Trends

1. Analysis done only for those counties with 5 or more years of data.
2. Judgements based on
   - o Number of days per year over standard
   - o Annual frequency distributions
   - o Annual average concentration
   - o Second highest concentration
   - o Trends in other sites within county

Indices

1. Select worst site in county based on
   - o Number of days greater than 160 $\mu g/m^3$
   - o Data available for at least one year (1974-76) during the months April through September.
2. For selected site, count the number of days per year (1974-76) with at least one hourly average greater than 160 $\mu g/m^3$. Average these yearly values.
   - o For periods with no data, estimate by examining data from nearby sites and for the same site during same period of other years.
   - o Data are insufficient if unavailable during the peak ozone season (April-September).
3. For same site, count number of days with at least one average greater than 400 $\mu g/m^3$.
   - o Actual number is always used

Trends

1. Analysis done only for those counties with 5 or more years of data.
2. Judgements based on
   - o Number of violations per year
   - o Number of days greater than standard for each year

- Annual frequency distribution
- Second highest value for each year
- Trend in other sites within county